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FOUCAULT'S PENDULUM EXPERIMENT.

THE great pendulum experiment of Leon Foucault having recently been repeated at the Tour St. Jacques at Paris, it has appeared to us to be of interest to publish some retrospective documents upon a scientific fact that once strongly attracted the attention of the public and of astronomers.

Foucault's first experiments were performed in the cellar of the house in which he lived, and the primitive apparatus used was made by Froment. Foucault thus describes it:

To the ceiling of the cellar was firmly fastened a strong piece of iron, from which depended a suspension wire, through the intermedium of a small piece of tempered steel, whose free surface was perfectly horizontal. This wire, which varied between 0·25 and 0·44 of an inch in diameter, had been hardened by the action of the draw plate. It was 6½ feet in length, and supported a polished brass sphere. Moreover, the latter had been so fashioned that its center of gravity coincided with its figure center. This sphere weighed eleven pounds, and was provided with a sharp piece of wire, which, in a state of rest, appeared to form a continuation of the suspension wire. The angle experimented with was from fifteen to twenty degrees. The start was effected through the aid of a loop made in a cord that was burned after it was made certain that gravity was giving no lateral impulsion. After a half hour of oscillations, the phenomenon became obvious, and it could be followed from minute to minute through the aid of a sort of style mounted upon a support that was placed upon the floor in such a way that the appendage to the pendulum grazed its extremity when it reached the limits of its travel.

After private experiments ensued those of verification These were performed in the southern hall of the observatory, and the results of them were given in a note read by Arago at the session of the 3d of February, 1851, and repeated a few days afterward before a select audience. Mr. Terrien, one of the two scientific editors of the *National*, informs us that the ticket of invitation was worded as follows:

"You are invited to witness the earth revolve, in the southern hall of the Paris observatory, to-morrow, at half past two."

The experiments were performed with a thirty-six foot pendulum. Mr. Terrien was so satisfied that he blamed Galileo for not having discovered the rotation of the plane of the pendulum, and attributed all his troubles to the fact that he did not have sufficient intelligence to carry demonstration up to this point. Mr. Foucault was not of this opinion, for he asserted that this property of the pendulum would only have been one obstacle more in Galileo's hands. The reason that it was demonstrable in 1851 was because of the progress of the times. It was because the revolution of the earth was believed in, and it was no longer a question of verifying this opinion. The comparison that he makes in an article in the *Debats*, May 31, is startling in grandeur: "Just as on the open sea the pilot has his eyes riveted on the compass in order to note the changes in the ship's direction, just so the inhabitant of the earth, through the aid of the pendulum, creates for himself a sort of compass in absolute space. The apparent motion of this instrument reveals to him the real motion of the globe that he inhabits."

After describing the numerous experiments that he had performed, Foucault exclaims: "Everywhere that a height of thirty or thirty-five feet is at one's free disposal he will be able to study, thoroughly and seriously, the influence of the earth's revolution upon the swing of the pendulum, and beneath the high domes of certain edifices the phenomenon ought to be of wonderful splendor. In the Pantheon we found a space admirably adapted for the installation of a gigantic pendulum, and we found the administration, too, most favorably disposed. Upon a simple description of the projected experiments, the President of the Republic resolved that the thing should be done. With the rapidity of lightning, his high protection reaching to the last round of the administrative ladder, the necessary apparatus was put up in less than a fortnight."

In the *National* of March 26, Mr. Terrien describes the experiment as follows: "Coming under the cupola

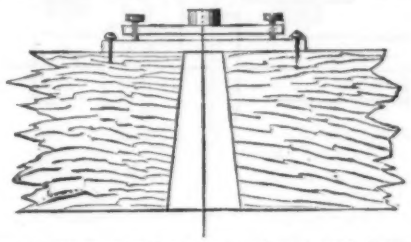


FIG. 2.—SUSPENSION OF THE PENDULUM.

of the Pantheon, you see a 220 foot steel wire suspended from it. At the other extremity there is a 66 pound copper ball. This latter, in its position of equilibrium, occupies the center of a circular gallery, divided into degrees, and rising to the level of the hand rail. The ball is held by a loop in a hemp cord, the two united ends of which are fixed outside of the gallery. When the cord is burned, the ball begins a series of oscillations whose ever-revolving plane, after an hour, with its initial direction, makes an angle of several degrees. An hour, say you. Don't be afraid, it will be an affair

FIG. 3.—ACTION OF THE PENDULUM UPON SAND.

of five minutes, of sixteen seconds, if you are in a great hurry. I say sixteen seconds. Why? By reason of its length, the pendulum takes sixteen seconds to return to its starting point. In this time the earth has revolved, and the pendulum responds to another division of the circle under which it is oscillating."

This circle was 70 feet in circumference, and at every double oscillation the pendulum moved sideways by from 0·08 to 0·12 of an inch, and this was shown by a visible trace made in a little pile of sand in which the pendulum made a breach that progressively widened (Fig. 3).

Although the amplitudes rapidly diminished, they were nevertheless visible enough at the end of five or six hours to allow the total side motion (60° to 70°) to be ascertained. To obtain this result, a table whose surface was traversed by a series of diameters intersecting at angles of from five to six degrees was placed within the circle. These lines not only permitted of ascertaining the motion sideways of the mean plane of oscillation, but revealed a new fact. The point of the pendulum never returned exactly to the vertical of the point in suspension, but it seemed that the tracing point described an ellipse upon the horizontal plane. The cause of this disturbance has never been exactly explained.

The wire was suspended as shown in Fig. 2. At the apex of the cupola, there was a cover which, when removed, left a circular aperture of five feet in diameter. Across this, from one edge to the other, was thrown a spruce joist of fifteen inches section, and the free space around this was boarded up. In the center of the joist, and in the axis of the dome, a conical aperture was made. It was through the latter that passed the wire attached to the metallic pieces shown on top of the joist in Fig. 2. As the wire thus arranged, and submitted to the action of a weight that stretched it from two to two and a half inches, sometimes broke, the mosaic pavement was covered with a wooden flooring on which was spread a thickness of about eight inches of earth. The ball was formed by hammering two hemispheres in a strong, very homogeneous iron plate. These were then soldered by running lead in, so that a mass was obtained weighing sixty pounds, with a diameter of seven inches.

Our large engraving (Fig. 1) shows the general arrangement for the experiment as it was performed at the Pantheon in the presence of spectators.

After the *coup d'etat*, the experiments were interrupted. They attracted a great crowd up to the ver last day. Every time that we entered the Panthec we found people gazing at the pendulum, even when i. was at rest. There was always some volunteer of science more or less intelligibly explaining to audi (who r .erstood him mor less perfectly) what the experiment signified.

It appears that Foucault himself sometimes took the trouble to demonstrate his apparatus to the public. We are told that he liked to hear the reflections that were made upon it. Perhaps we, without knowing it, had the honor of receiving from his lips the explanation that has remained engraved on our memory, but, not knowing the illustrious inventor personally, we can make no affirmation in regard to this. What we can assert is that the instruction thus received has profited us, for we have forgotten nothing at all of what was told us thirty-five years ago. We recall one very interesting detail. The last time that we visited the Pantheon during the interval between two lectures that we were attending at Saint Barbe College, the wire broke in front of us, but there was no accident, and nothing became detached from the cupola, otherwise some of the spectators would have been wounded. We were apprised of what had occurred, and were told that Foucault had devised what was called a parachute. As the wire always broke close to the jaw, it sufficed to provide it, a little beneath and a little above the aperture, with a collar that held the suspended wire until somebody came to fix it.—*W. De Fouveille, in La Nature.*

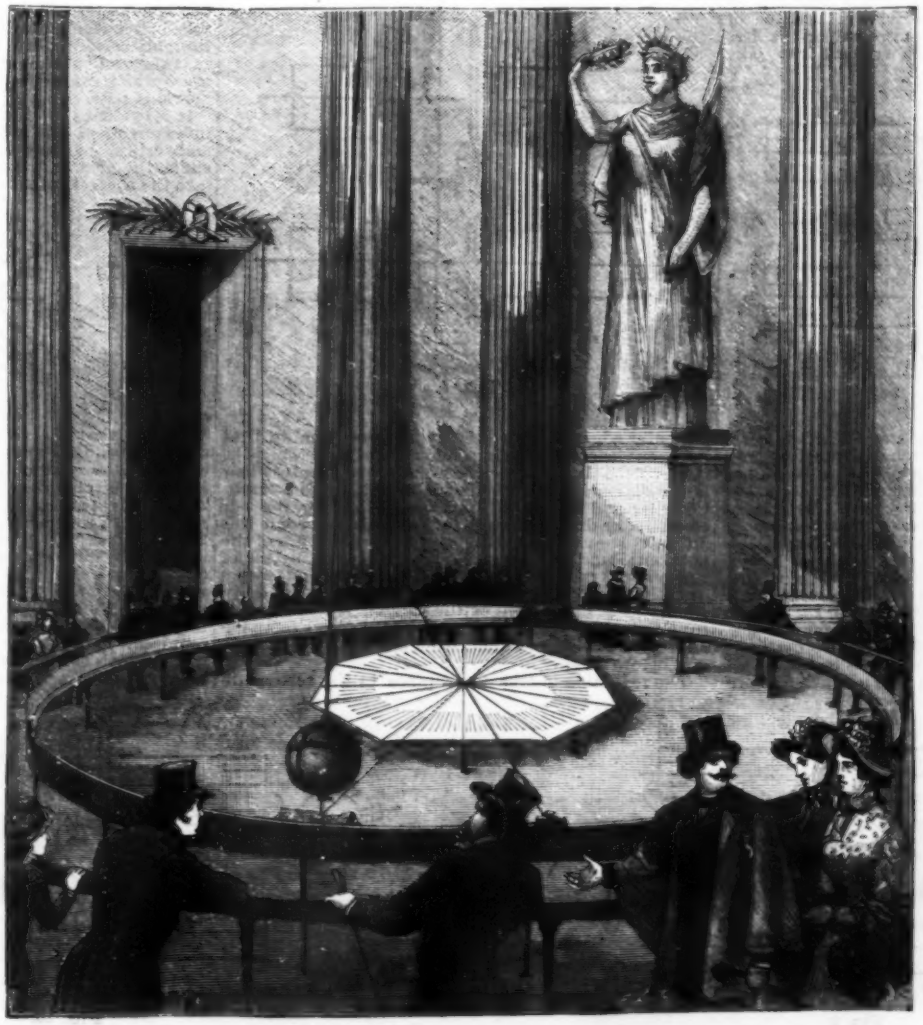


FIG. 1.- UCAULT'S PENDULUM EXPERIMENT AT THE PANTHEON IN 1851.

GEORGE RIEBALD, an Idaho pioneer and mine owner, says that Joaquin Miller named the Territory "Idaho," being a pure Bannock word, meaning "Gem of the Mountains." Miller himself says that the word should be pronounced with the accent on the second syllable, I-*da*-ho, the "a" having a broad sound.

IMPROVED UNIVERSAL ROLLING MILL.

HERR HUGO SACK, of Duisburg, has produced a mill which is being vigorously pushed into notice in Germany. It is adapted to the rolling of the double angle or star section, of sizes varying from 8 in. to 18 in., and enables him also to roll H, T, and similar sections of large dimensions with an economical distribution of material. It is also possible with this system to work mild steel, which could not readily be done before. This is accomplished by means of a pair of rolls, correctly described as loose rolls, mounted upon or cast in one with vertical spindles, the axes of which are situated in the same plane as those of the horizontal rolls, the

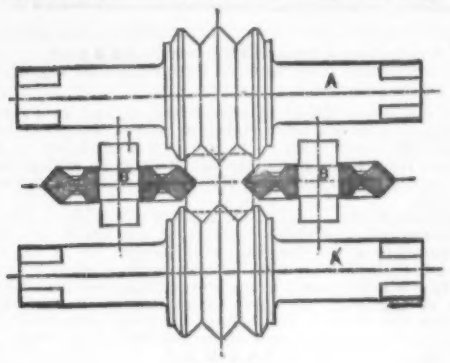


FIG. 1.

loose rolls being placed between the horizontal rolls, so that the point of nearest approach is in one and the same vertical plane.

The outer surface or face of each vertical roll is shaped so as to produce on the bar the required impression. These rolls are shown in section in the first and last position, in Figs. 1 and 2 for the star profile and in 3 and 4 for the double T section. Their use being only to retain the material operated upon in its desired shape, the spindles are not required to undergo any torsional strain, and are relatively of small diameter. They are so mounted that their vertical adjustment is made dependent upon that of the upper horizontal roll. As the latter descends, the vertical rolls descend with it, but only through half the distance, so that they always remain central. When pressed in laterally toward the center by means of the horizontal adjustments provided, they bear upon the bar and support it while it is being subjected to the pressure of the horizontal rolls, which are driven in the usual way. At the end of each pass the iron is turned over—a quarter turn in the case of the star section, a half turn for the double T section. For the former section the vertical rolls are similar; for the latter they are dissimilar, as shown. By turning the bar, that side which has just emerged from before the roll, B, is, during the next pass, pressed upon by the roll, B^1, and in this way fins are removed. In our illustrations the upper horizontal roll is marked A, and the lower A^1. Figs. 5, 6, 7, show the working surfaces and the bar passing through them to a somewhat larger scale for the double T mill. The shape of the bar before passing through the rolls is indicated by the dotted line. Fig. 5 shows the relative position of the working surfaces forming the groove for the first pass of a previously roughed down wrought iron pile.

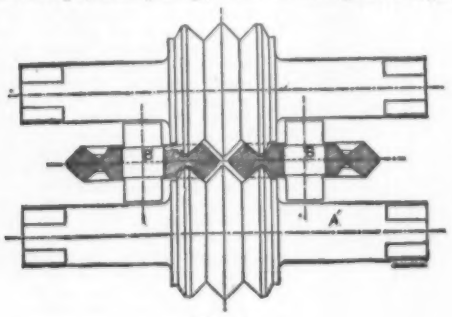


FIG. 2.

Fig. 6 shows an intermediate pass, and Fig. 7 the last pass on the mill. Since with wrought iron there is a danger of the material opening and tearing out if not firmly griped from all sides, the rolls are so set as to form a closed section after the first pass. With ingot iron this precaution is not necessary, and since the preparation of a rectangular section is more simple, this is adopted, as shown in Fig. 3.

It will be noticed that the profile is unsymmetrical, one of the vertical rolls being, as already stated, smaller than the other, and of such shape that the flanges on the horizontal rolls reach over its circumference. The flange of the other and larger vertical roll, marked B^1 in our illustration, is of such shape as to reach over those of the horizontal rolls. In this manner the production of permanent fins is avoided. A fin must evidently be formed at the junction of two surfaces if the metal at that place is under a certain pressure, because it would be impossible to make the surfaces a close fit; but the fin which is produced in one pass is removed in the next, owing to the turning over of the bar, which is one of the important features of this rolling mill. Thus the fins which are produced on the two outer edges of the right hand flange of the girder in one pass (Figs. 6 and 7) are in the next pass effaced by being pressed into the angles of the left hand vertical roll,

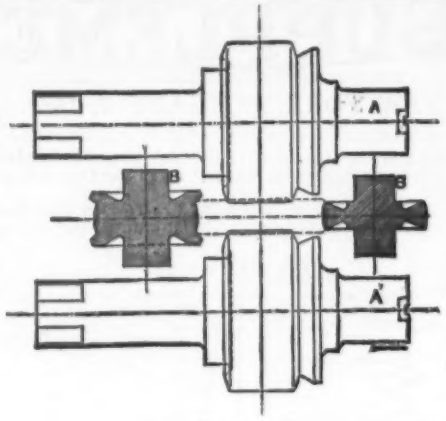


FIG. 3.

while the fins produced at the inner edges of the left hand flange during one pass are effaced by being pressed into the angle of the horizontal rolls in the next pass.

It will be noticed from our illustrations that in the double T mill the outer circumference of the vertical roll is not a cylindrical surface, but has a considerable camber, thus producing curved flanges in the girder. The reason of adopting this shape is that the wear on the side of the rolls is thereby greatly diminished, owing to the shorter time the rolls remain in contact with the face of the flanges. Whereas with vertical flanges scraping takes place, as already explained, in the Sack arrangement of inclined flanges a kind of rolling motion is substituted. When the bar has passed for the last time through the universal rolling mill, the flanges must be straightened on a special finishing mill, having two rolls only, serving for three to six sections according to size, and giving only as much reduction to the section as is necessary to produce the final shape.

In the rolling mill for the cruciform or star shaped section both vertical rolls are of the same size, and the arrangement is in every way symmetrical. Figs. 1 and 2 show these rolls in position for the first and last pass. In this case the horizontal rolls overlap the circumference of the vertical rolls, and to make this possible without jamming, it is evidently necessary that the diameter of the vertical rolls should be slightly larger than that of the horizontal rolls. If the distance between

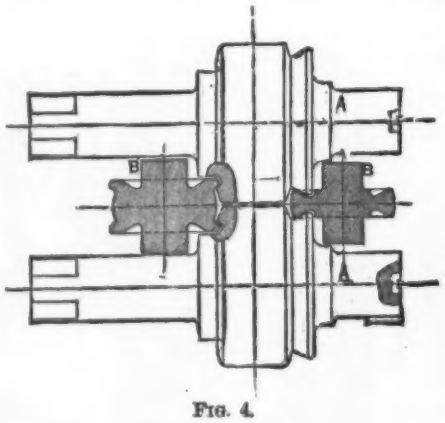


FIG. 4.

the outer edges of the vertical rolls were equal to that between the corresponding edges of the horizontal rolls, it is evident that the former would, by reason of their larger diameter, gripe the bar sooner than the horizontal rolls; and as vertical rolls are not driven, the bar could not be drawn through the mill. To overcome this difficulty the angle of chamfer on the outer cones of the horizontal and the corresponding under-cut surface of the vertical rolls is slightly less than 45°, and consequently the edges of the cruciform section are not quite square with the surface of the flanges, as will be seen from the annexed sketch (Fig. 8), which shows to an exaggerated scale the section, after passing in full lines, and before passing in dotted lines.

The reduction of area takes place in the vertical dimension only, and is entirely produced by the horizontal rolls, thus relieving the vertical rolls of pressure. As a further consequence the formation of a fin at the corners marked *a*, that is, at the junction between the vertical and the horizontal rolls, is almost entirely avoided, as the material receives no pressure there. It is a peculiarity of the Sack rolling mill that the surfaces need not be in close contact, a matter of considerable importance, because of reducing wear and tear. Owing to the angle of chamfer being less than 45°, the vertical dimension of the finished pass is smaller than its horizontal dimension; and when the bar is turned through a quarter turn ready for the next pass, its horizontal dimension becomes the smaller, and thus the

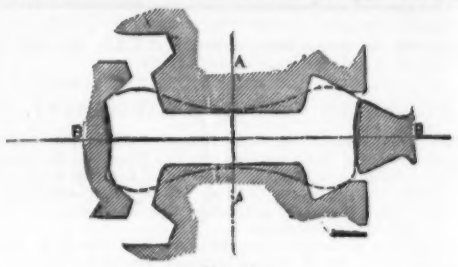


FIG. 5.

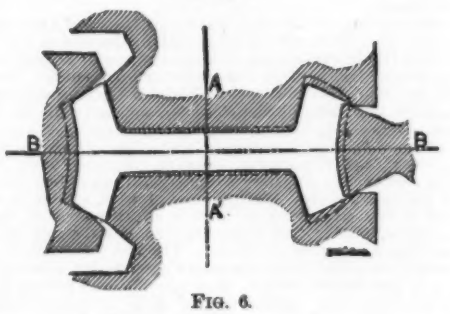


FIG. 6.

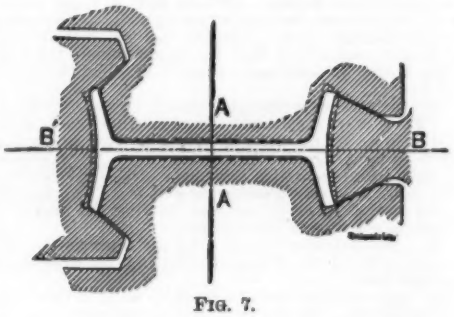


FIG. 7.

bar can be pushed in to be griped by the horizontal rolls before coming into contact with the vertical rolls. Roughly speaking, the mill is set after each pass, so that the vertical rolls approach to within the same distance which existed between the horizontal rolls in the previous pass.

It is evident that the angle of chamfer will have an influence upon the relations between the horizontal and vertical dimensions of the section; the smaller this angle, the greater the difference. We need not enter into the theoretical investigation at present, but it can

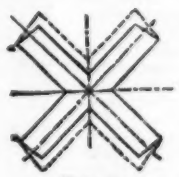


FIG. 8.

be shown that the geometrical tangent of this angle should be equal to the ratio of reduction between successive passes. After the last pass the bar is left with a slightly displaced section, and complete symmetry is restored by passing it through a finishing mill with four smooth rollers in general arrangement similar to the universal mill. Owing to the rolls of this mill having smooth surfaces, and not rough, as in the universal mill, where a firmer grip is necessary, the bar is left with a good finish. As it is not necessary to give pressure upon the edges of the sections, one finishing mill may serve for all the cruciform sections which may be required.

As regards the adjustment of the vertical rolls in the universal mill, it has already been pointed out that the

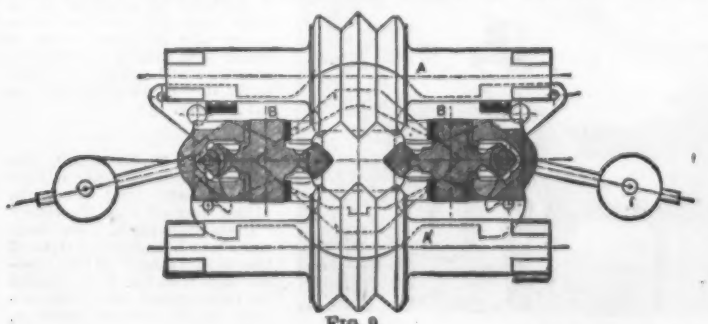


FIG. 9.

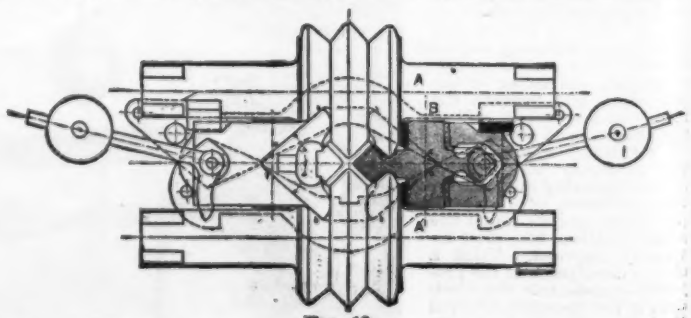


FIG. 10.

UNIVERSAL ROLLING MILL.

bearings of these rolls are adjustable both in a vertical and horizontal direction, the vertical movement being half that given to the top horizontal roll. The vertical rolls are drawn apart by balance weights, *f* (Figs. 9 and 10), acting through bell crank levers, the shorter arms of which press against the housing for the horizontal rolls. The housing blocks for the vertical rolls are provided with wedge shaped projections fitting between the inclined surfaces, *a b* (Figs. 9 and 10), the inclination, *a*, being evidently the same as the chamfer of the under-cut surface in the vertical rolls already mentioned. By this means the ratio of approach of the vertical and horizontal rolls is equal to the geometrical tangent of this angle, and satisfies the condition above stated, viz., that the horizontal dimensions of one pass should equal the vertical dimensions of the previous pass.

Owing to the symmetry of the upper and lower wedges, the center of the vertical rolls is always kept exactly midway between the axis of the horizontal rolls, and perfect symmetry of the section as regards its horizontal center line is insured. A very similar design is used for the double T mill, with the only difference that the angle, *a*, is considerably smaller, its tangent being about 0·5. The mathematical reasoning by which this result is arrived at need not occupy us here. Suffice it to say that with such an angle the rolling of sections where the web and flanges have equal thickness is feasible. On the finishing mill the edges of the flanges are slightly compressed, so that the flanges retain their thickness, while the web is subjected to a further pressure and becomes thinner, so that the finished girder is of the section usually found on the market.

The latest arrangements of Sack's universal rolling mill for double T and cruciform sections are as follows: Fig. 11 is a transverse section through the rolling mill for double T iron, Fig. 12 an elevation partly in section, Fig. 13 an end elevation, Fig. 14 a sectional plan, and Fig. 14 shows the footstep of the horizontal rolls in plan, this being used to adjust the position horizontally. The housings of this mill are in no way different from those now usually employed in ordinary rolling mills, so that they may serve for various purposes. The lower horizontal roll is fixed in adjustable bearings, D, let into the housings, while the height of the bearings, D^1, of the upper roller is controlled by the usual screws and top gear.

The same construction is employed in the universal mill for cruciform sections, shown in elevation in Fig. 15 and in plan in Fig. 21. The bearings for the vertical rolls are carried in housing blocks, A, which are provided with wedge shaped projections, B, sliding

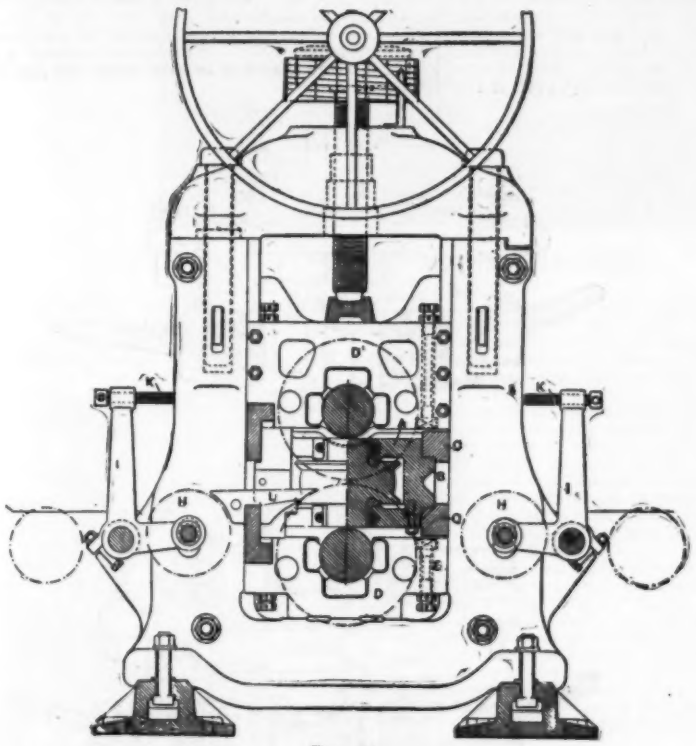


FIG. 11.

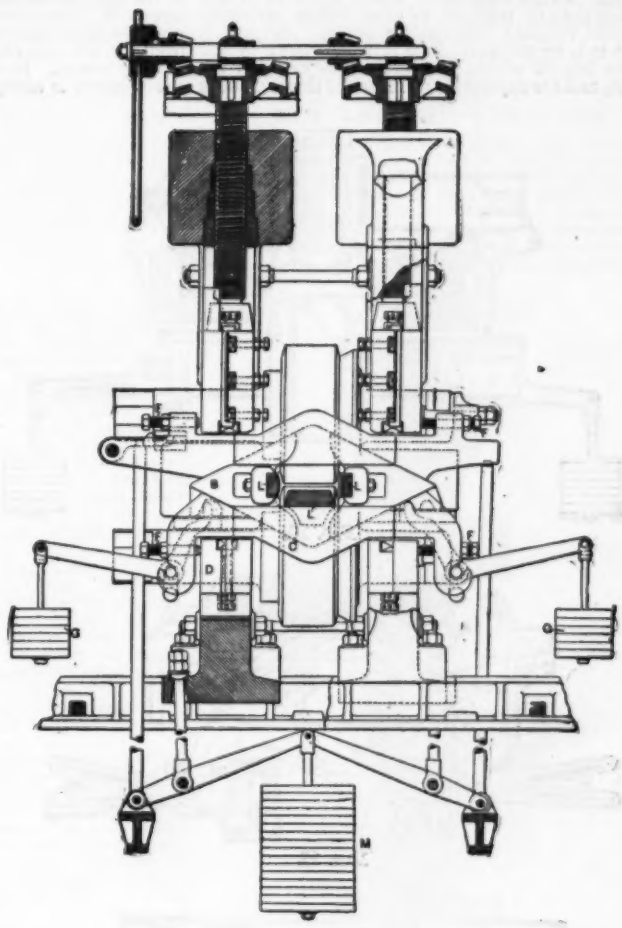


FIG. 12.

FIG. 13.

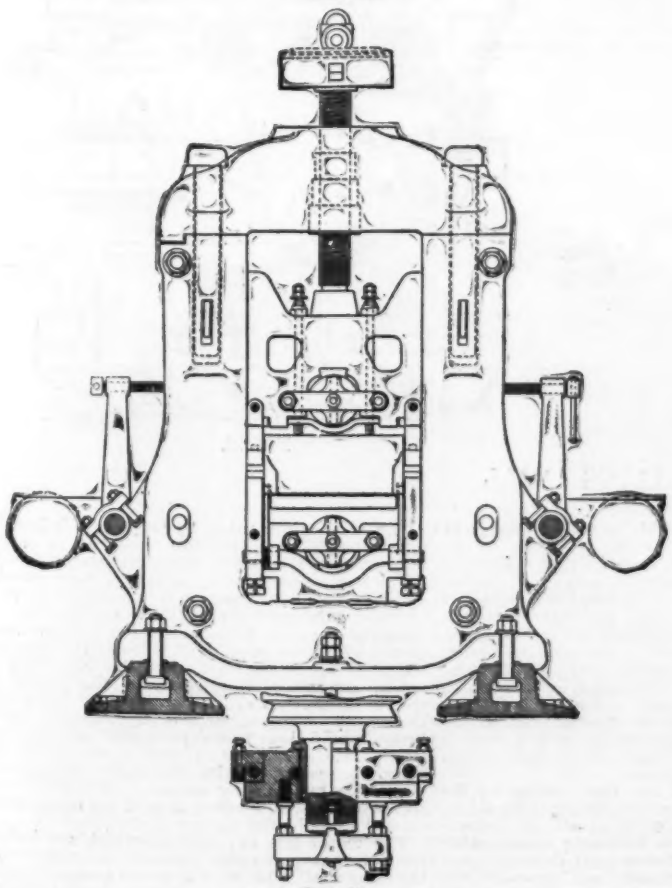


FIG. 14.

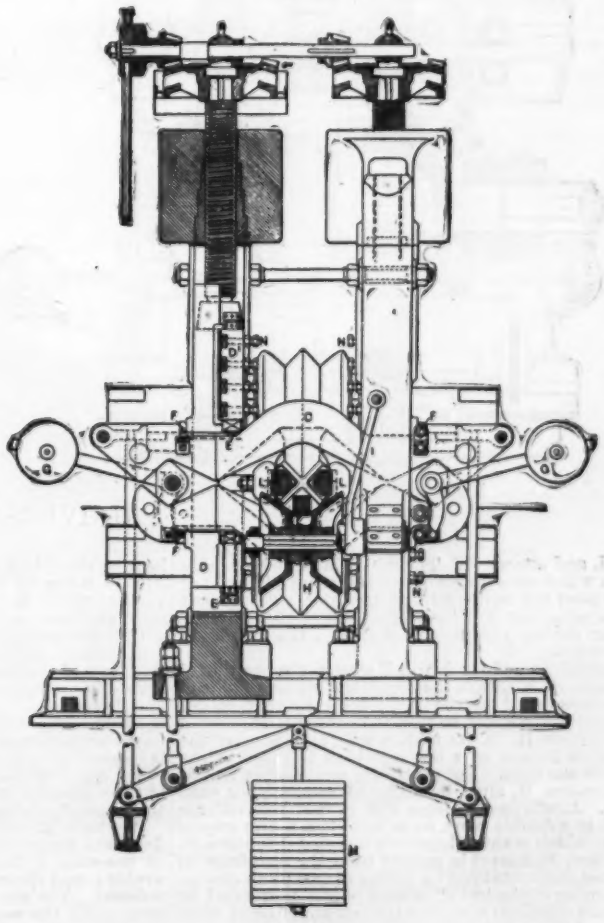


FIG. 15.

UNIVERSAL ROLLING MILL.

within inclined rails, C. The bottom and top rails are supported and adjusted vertically by screws, E, passing through the bearing blocks of the horizontal rolls, while the horizontal adjustment is provided for by screws, F, in the case of the double T mill, and wedges, F, in the case of the mill for cruciform sections. The exact position of these rails is a matter of importance, because it affects the setting of the vertical rolls; and since the screws are all easily accessible, the adjustment can be performed while the mill is at work. By screwing down the top horizontal roll the two inclined top rails are also lowered, and force the wedges, B, toward each other, thus reducing the distance between the vertical rolls. This will be more clearly seen from Fig. 17, which shows the position of the rails, C, at the beginning and end of the rolling, the former position by full and the latter by dotted lines. On raising the screws the housing blocks are pulled apart by the action of the balance weights, G, which, however, in certain cases, may be replaced by small steam cylinders. The bloom, roughed down and ready for the mill, is brought to it by the usual train of rollers sunk in the floor, the last of which, H, however, lie between the housings, and are adjustable by means of the bell crank levers and weight, M. The distance between the housings of the horizontal rollers is a constant for all sizes of the cruciform section, and for the double T mill for all sizes of girders from 8 in. up 18 in. The two sizes are shown in Figs. 19 and 12. For larger girders, as shown in Fig. 20, one of the housings must be shifted and new rails fitted. In the rolling mill for the cruciform section the footstep shown in Fig. 14 is not used, the width of collar on the horizontal rolls being sufficient on both sides to provide the necessary bearing surfaces against the brasses, and consequently two or three mills for cruciform sections can be coupled together in the way now commonly employed. In the rolling mill for double T iron this is not possible, on account of the footstep, and this train must therefore always be placed the last in the series.

The footstep for the double T mill is adjustable by screws, as shown, while the corresponding adjustment in the mill for the cruciform section is obtained by the screws, N. These must be set on both sides, the resultant pressure being sometimes from the right and sometimes from the left, accordingly as the bar is more or less unequally heated. In the mill for the double T section the pressure is always from one side only, even if the

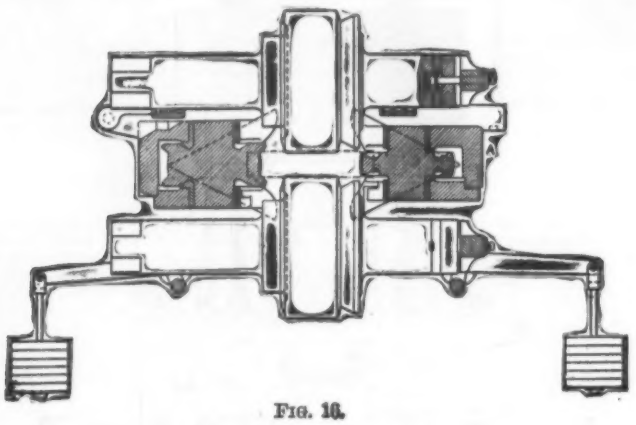


FIG. 16.

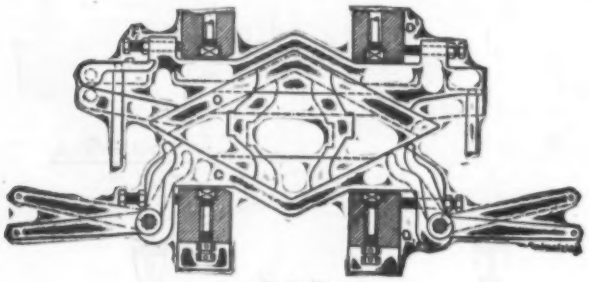


FIG. 17.

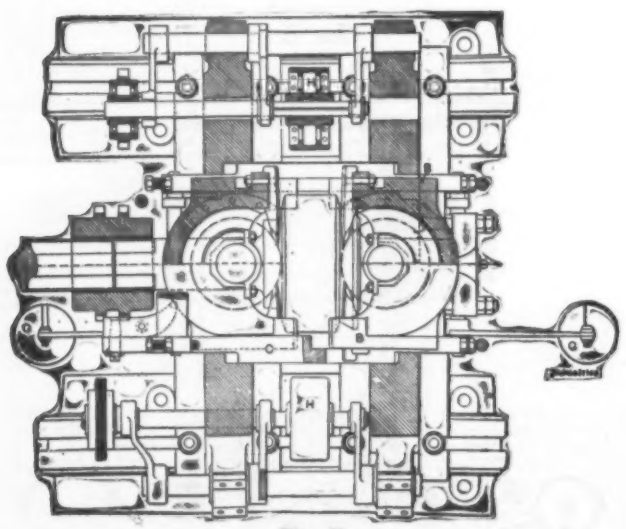


FIG. 18.

levers, I, and screws, K. The mill is intended for large sizes, in which case it would be a reversing mill, so that the bar need not be lifted from the floor. To prevent the wrapping round of the bar in case of the material splitting during the process of rolling, the guards, L, are provided.

In the rolling mill for double T section the position of the rollers, H, is always the same, the highest point of these rollers being on the same level as that of the horizontal bottom roll, so that the girder is supported by the rollers, H, on its middle web, and not on the edges of its flanges, as is the case with the rest of the rollers on the floor. For cruciform sections the height of the rollers, H, must be adjusted specially for each section. It will be seen from Fig. 15 that this roller is formed as a double cone, so as to obtain a firm grip of the bar, which is thus vigorously inserted into the mill. The rollers, H, are set in motion from the couplings on the lower horizontal roll by means of two pitch chains. The turning of the bar after each pass is performed by hydraulic machinery, so that the amount of hand labor is reduced to a minimum.

The weight of the top horizontal roll and of the upper inclined rails, C, is counterbalanced by a system of

UNIVERSAL ROLLING MILL.

heating should be unequal. This, as will be seen from Fig. 16, is due to the larger surface presented by the vertical roll on the left, which overlaps the horizontal rolls, and thus no backlash in the rolls can take place.

The absence of blacklash in this mill is a matter of considerable importance, because a difference in the thickness of the flanges of a double T girder would considerably influence the moment of inertia of the section and its strength. In the cruciform section a slight inequality in the thickness of the flanges is not of so much importance, because the strength of the finished girder is by such inequalities much less affected than in the other case. Rolling mill engineers know how important the question of wear and tear is in connection with this class of machinery.

We have already pointed out that, owing to the flanges of the section being inclined, the scraping action of the sides of the horizontal rolls is almost entirely avoided, and the wear and tear is thereby considerably reduced. The size of the different journals is so chosen as to make the wear proportionate and approach the centers evenly, so as to maintain the section of the bar notwithstanding the wear in the bearings. Care is also taken in the design to protect the bearings, and the sliding surface of the inclined rails, from scale. The only place where scale can accumulate is the under-cut trough in the vertical rolls, and from there it must be washed out from time to time by a jet of water. If after a time the rollers must be returned, the original outline is, owing to the inclination of the surfaces, easily obtained again.—*Industries.*

FOREST'S PETROLEUM BOAT.

WE already had the steam boat and electric boat, and now we have a petroleum one.

We might almost apply the name of gas boat to the yawl Volapuk, that Mr. Forest, an ingenious mechanical engineer, has recently built, since the motor that propels it is a six horse power gas engine. (Fig. 1.)

It is not illuminating gas that is employed here, but air charged with carbureted hydrogen by passing through gasoline. We have already spoken of the advantages to be derived from the use of this material, and we have seen that carbureted air mixed in proper proportions with ordinary air produces a detonating mixture that may be used under the piston of a motor.

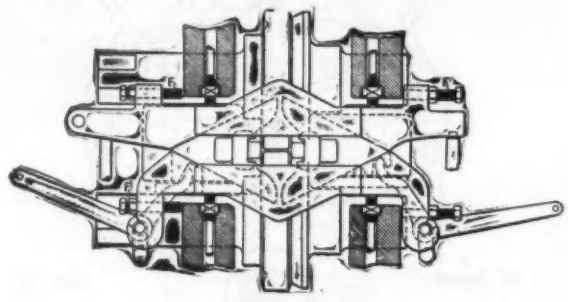


FIG. 19.

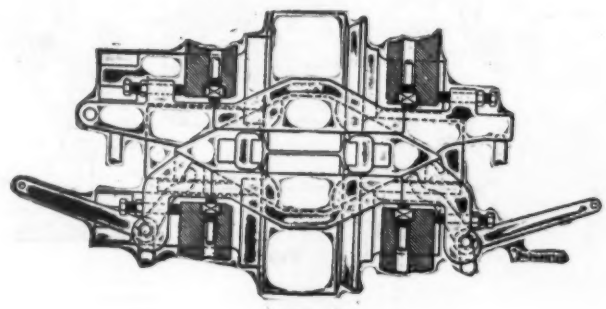


FIG. 20.

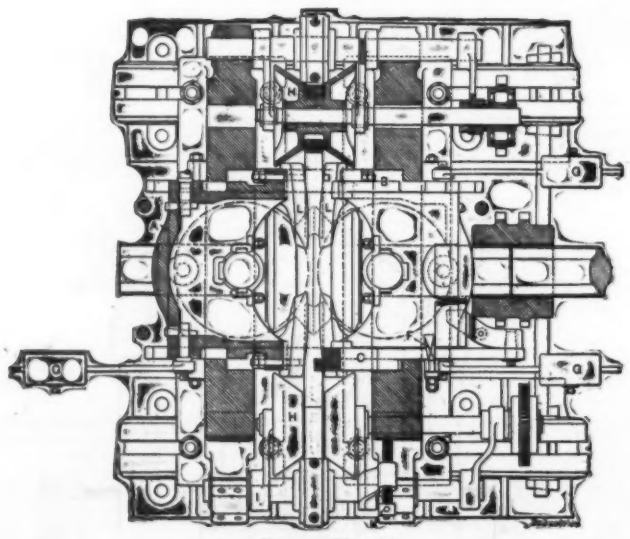


FIG. 21.

The application made by Mr. Forest is based upon this principle, and therefore comprises a carburetor and a motor in which an explosive mixture is used.

The former of these apparatus is very simple, and occupies but little space. It consists of three small cylinders arranged horizontally, and having a total capacity of about ten quarts. The first of these contains a supply of gasoline that keeps the liquid in the second at a constant level. It is this latter that the external air, sucked in directly by the pistons of the motor, enters. In order that it may become charged the better with carburet of hydrogen, a helicoidal brush, whose lower part dips into the gasoline, revolves slowly in the cylinder in such a way as to be constantly impregnated with the liquid and to present a very wide evaporating surface. The third cylinder serves to arrest and collect such of the liquid as may be carried along by the current of air.

The motor has two pistons, which are inclosed in the same pump chamber and act simultaneously upon the same shaft. In order to get an idea of this arrangement, it will suffice to imagine an open cylinder containing a piston at each end, and the two meeting at the center. If, at this point, steam or gas under a

high pressure be introduced between the pistons, it is clear that the latter will both be acted upon with equal force, and that their stroke may be utilized to revolve a fly wheel.

FIG. 1.—FOREST'S PETROLEUM BOAT.

The object of this arrangement, as adapted by Mr. Forest, is to distribute the effect produced by the explosion upon the shaft better.

The explosive mixture is, as we have said, sucked in

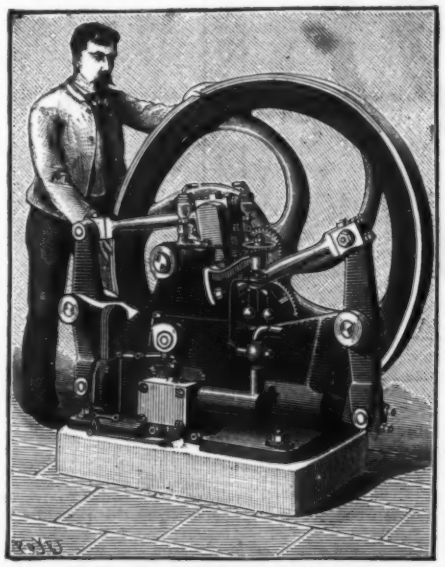


FIG. 2.—PETROLEUM MOTOR.

directly by the pistons. As it enters, it traverses a system of valves that open at the desired moment to give access to each gas (carbureted and pure air) in definite proportions, and that afterward close when the pistons begin to approach each other and compress the mixture.

When the pistons are at the end of their stroke, a spark produced by a magneto-electric device appears in the mixture and fires it. The pistons then produce their useful effect and act upon the fly wheel shaft. When they return toward each other for a second time, the gases are expelled through a special valve that opens at this moment. Then everything is arranged anew for a suction, compression and useful effect. As may be seen, the pistons act effectively, as in nearly all gas motors, only at each two revolutions of the fly wheel. In order to have an action at each revolution, it would be only necessary to increase the number of pistons, in which event we should have more force and might be able to reduce the size of the fly wheel.

The cooling is effected naturally by means of a circulation of water.

The engine that is used on the Volapuk was not built for this purpose, but is rather a workshop motor. It has two vertical fly wheels, and motion is transmitted to the helix shaft by a bevel gearing. It has a power of six horses, and consumes four quarts of gasoline per hour to give the boat a speed of 3½ miles per hour. In a six horse power motor now constructing, and designed for the boat of an amateur living near Lake Geneva, the engine contains some notable improvements that will reduce its size and decrease the jarring.

The application of this style of motor to navigation is a happy idea, for we thereby dispense with the cumbersome boiler used on steamboats, with all the accessories attached to it, with the need of a fireman, with a supply of coal, etc. It is pleasure sailing especially that will profit by these various advantages, and many lovers of nautical sport who have hesitated at the use of steam motors will take advantage of this new application of gas engines.—*La Nature.*

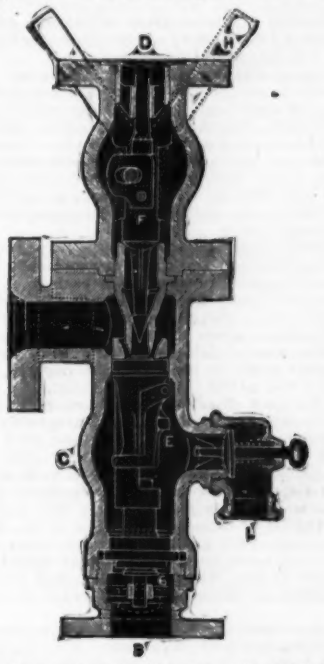
ENGINES OF THE SPANISH CRUISER REINA REGENTE.

WE give an illustration of one set of engines of this fast cruiser, for which we are indebted to the *Engineer*. There are two sets in this ship. They are of the triple expansion type, one being placed forward of the other in separate compartments. The diameters of the cylinders are 40 in., 60 in., and 92 in., the stroke being 3 ft. 9 in. The engines are exact duplicates of each other in every respect, the high pressure cylinder being forward in the forward engine room, and aft in the after engine room. The crank shafts, propeller shafts, and all the moving parts are of steel. The stern shafting was made by Beardmore, the rest of the shafting by Vickers. The bedplates are of cast steel, made by the Steel Company of Scotland. The valves are all of the piston type, driven by independent cylinders. On the trial they reached 110 revolutions, which is equivalent to a piston speed of 825 ft. a minute. The whole of the auxiliary engines are independent excepting the air pump, which is driven by a rod connected with a low pressure piston. The shafting is 17 in. dia., with an 8 in. hole in it. These engines are supplied with steam by four double ended boilers, each having eight furnaces in it, or thirty-two furnaces in all, the pressure of steam being 140 lb. The forced draught arrangements are very complete, each stokehole having two fans.

Illustrations of this remarkable war ship will be found in SUPPLEMENT, No. 623.

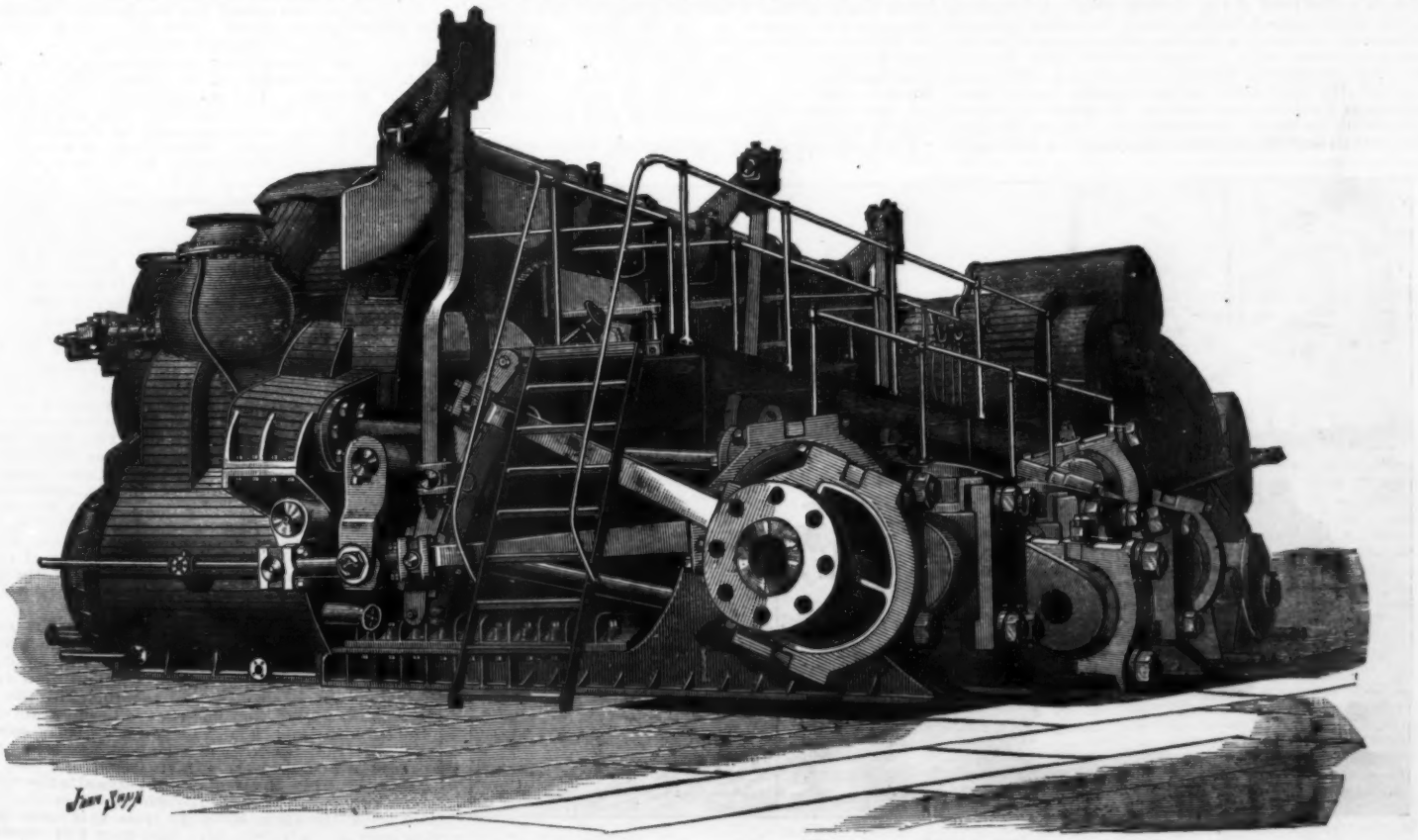
NEW RESTARTING INJECTOR.

CONSIDERABLE advance has of late years been made in the construction of injectors by the introduction of various kinds of automatic detail. Their manipulation is now a matter of great simplicity and certainty as compared with the earlier types, which frequently required a considerable degree of skill in their working. Generally speaking, this automaticity of action is attained by the use of a moving nozzle or valve, which



provides a free escape for the steam through the over flow while the injector is lifting the water, but establishes a continuous jet when the water enters the injector, and thus produces condensation of the steam admitted.

In the injector shown above, which is constructed by



COMPOUND ENGINES OF THE REINA REGENTE.

Messrs. Schaffer and Budenberg, Manchester, automatic action is effected by the use of a split nozzle, E, closely resembling that employed in the exhaust injector. When the injector is being started, steam, entering at D, and passing through the usual steam nozzle, will cause the hinged flap, E, to leave its seat, allowing a free escape toward the overflow, L; but when the water enters, producing condensation of the steam, the flap is instantly forced against its seat by the surrounding atmospheric pressure, so as to form practically an ordinary combining nozzle. The delivery end, B, of the injector is fitted with a non-return valve, G, in the usual manner. The regulating spindle, F, is actuated from the handle, H, by means of a small eccentric pin moving in a slot. By this means the steam admission valve may be effectively closed without difficulty. The overflow is provided with a valve held lightly to its seat by a spring, merely to prevent the admission of unnecessary air. We understand that this injector can be constructed to lift water to a height of 26 ft., and it will feed against a pressure double that of the steam pressure. It can be throttled down to less than half its capacity without wasting water at its overflow, and it will continue to work under large variation of steam pressure without the necessity of altering the position of the regulator handle. We are informed by the makers that this injector has been very extensively adopted in Germany, especially for use on locomotives, where it is usually fixed above the foot plate, under the direct view and control of the driver.—*Industries.*

THE NATURAL GAS INDUSTRY AT PITTSBURG, PA.

As illustrative of the progress of natural gas in the above region a brief history of the Chartiers Valley Gas Company will be found interesting.

The company was organized by a number of Pittsburg manufacturers, for the purpose of supplying their own mills and manufacturing establishments with natural gas for fuel. On the 31st day of July, 1883, operations were begun in the Washington County gas field, near the town of Hickory, by purchase of twenty thousand acres of gas territory. This territory had been developed by a number of gas wells, among others the celebrated McGugan well, which first brought this field into prominent notice.

The company has since acquired, by purchase and lease, nearly two thousand acres in the Murrysville district, situated about twenty miles east of Pittsburg; fifteen hundred acres in the lately discovered Grapeville district, situated eight miles east of Murrysville; over one thousand acres in the Glenfield district, situated six miles west of Allegheny City; and, lastly, over four thousand acres in the Sheffield district, situated twelve miles west of the Glenfield district.

In the Hickory district the Chartiers Valley Gas Company has twenty wells; in the Murrysville district, eighteen wells producing gas, and four now drilling which will be finished by December 1, 1887; in the Glenfield district the company has five wells and in the Grapeville district one well drilling, making a total of forty-eight wells which the company will have ready for use on the 1st of December. Owing to the care with which the company's gas territory has been selected, only two holes have been drilled that failed to produce gas, one in the Hickory district and one in the Glenfield district. These are not included in the above list.

Of the above forty-three wells which are now producing gas, several are held in reserve. The wells held in reserve all have the casing firmly anchored down and the gas shut in, ready to be turned into the line at a moment's notice.

CONNECTING WELLS TO MAIN LINE.

The method of connecting the wells to the main line is shown by Fig. 1. The casing that is put in the well extends to the level of the derrick floor. A branch is bolted to this casing, having one of its outlets pointing straight up the derrick and the other going off at the side at an angle of 45°. Upon each of these outlets, which are usually six inches in diameter, a gate valve is bolted, the gate valve on the upright branch having a pipe bolted to it to conduct the gas to the top of the derrick in case it is necessary to blow off the gas. The branch leading out of the side has also a gate valve bolted to it, and from this valve a curved pipe leads into a tank placed near the well to separate and collect any water or oil that may be carried along with the gas as it leaves the well. The pipe which enters the tank on the left side extends into it six inches beyond the center, and the pipe which leaves the tank on the right side extends into it and *past* the inlet pipe, they overlapping each other twelve inches, so that the gas as it enters the tank has to change its direction in order to get out, and in doing this the water falls to the bottom of the tank and is blown out at the small valve shown at the side. A by-pass is constructed around the tank, and gate valves placed on each side and in the center of the by-pass, so that the gas can be conducted around the tank in case it needs repairs. A man-hole is placed at the bottom of the tank and a safety valve on top. The cut also shows the anchor rods leading down on each side of the casing in the derrick. These rods are fastened below to a heavy timber foundation embedded in the ground, and above to a stirrup over the gate valve; then, by means of a right and left hand screw swivel, placed in each rod, the casing is drawn firmly down, so that it will resist the full pressure on it when the well is shut in. All the fittings used about the wells are enormously heavy, so as to withstand the great pressure of the well when shut in. The reason for connecting the wells in this manner is to prevent the great loss of gas by friction in passing the many tees and elbows that are generally used in connecting wells to the main line.

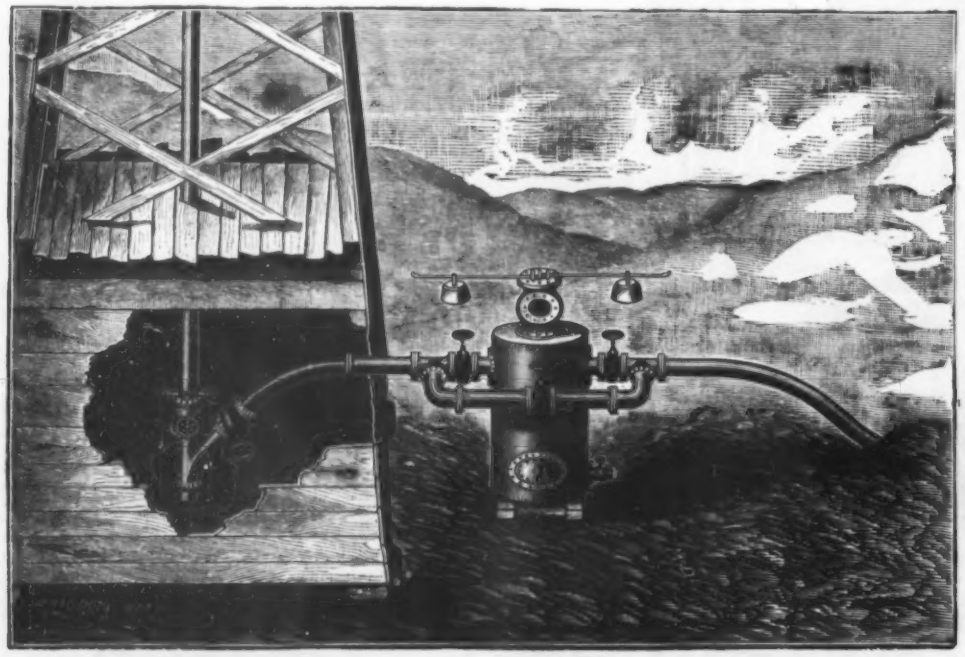


FIG. 1.—MODE OF CONNECTING GAS WELL TO MAIN LINE.

The first main laid by the Chartiers Valley Gas Company was from the Hickory gas field to Pittsburg, and consisted of an eight inch wrought iron line beginning at a point about three miles beyond the town of Hickory and extending to Mansfield, from which point a ten inch wrought iron line was laid to the city. This line was commenced in the fall of 1883, and was the first line laid on the "telescope" principle in this vicinity, which has now been generally adopted by all the gas companies. This principle consists in starting from the wells, where the pressure is high, with smaller pipe than is used as you get farther and farther away from the wells, and the pressure continues to decrease as the distance becomes greater from the point of supply.

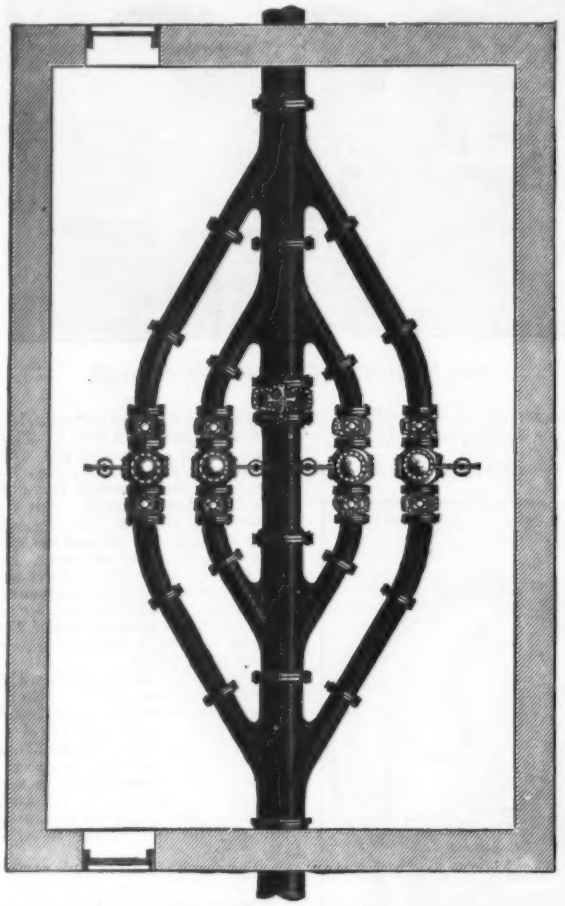


FIG. 2.—GAS REGULATING STATION FOR REDUCING THE GAS PRESSURE.

A second eight inch wrought iron line was laid from this same field in the summer of 1885 as far as Mansfield, and connected into the ten inch leading to the city. A ten inch branch was also laid from the ten inch line near the city limits to McKee's Rocks and Chartiers, to supply the mills and factories at those points, and then laid across the river at Brunot's Island to Allegheny City.

By the time this second line was finished, the demand for natural gas in the two cities was so great, being far beyond what the companies then doing business could furnish, that the company decided to lay a 16 inch line from their gas territory in the Murrysville field to the city of Pittsburg. This was six inches larger than any other line that had ever been laid from any gas field.

Much difficulty was experienced in determining the best kind of pipe to lay, whether cast or wrought iron, and the best method of joining the pipes together. It was not deemed advisable to lay cast iron, as under the pressures to be carried, the gas would probably leak through the pores of the iron. The screw thread could not be used for joining the pipe together, as it was not practicable to make a screw thread on pipe larger than twelve inches in diameter. It was finally decided to lay wrought iron pipe and join it together by the Converse patent joint, which is made by locking the two pieces of pipe together and then making the joint with lead, both pipe and joint being made by the National Tube Works Co., of McKeesport, Pa. This line was laid in the winter of 1885–86, and was then the largest continuous pipe line in the world. It was very successful, giving the Chartiers Company when completed a capacity second to but one other company in the city, and in the entire period of two years that it has been delivering gas, only once has the flow been interrupted, owing to the pipe parting, and the parting was caused by the slipping of a hillside, which carried the pipe away with it. This line starts at Murrysville, and runs through the town of Monroeville, then through the town of Homestead, crossing the Monongahela River at Munhall Station by means of six ten inch lines, laid four feet under the bed of the river, and entering the city of Pittsburg on the South Side above Jones & Laughlin's mill.

The next line laid by the Chartiers Valley Gas Company was from the new Glenfield gas field, where the company had acquired considerable territory and some strong wells. This line was of wrought iron twelve inches in diameter, and joined together with the Converse patent joint, that had proved so successful on the sixteen inch line. This twelve inch line crosses the Ohio River at the town of Glenfield, and is laid along Neville Island and across Davis Island, and then back across the Ohio River at a point opposite the western city limits of Allegheny. In each case where the line is laid across the Ohio River the crossing is made by two ten inch wrought iron lines laid four feet under the bed of the river. The length of this line from the wells

to the city is only six miles, and while the field is not so strong as any of the other fields from which the Chartiers Company receives gas, still, being such a short distance from the city, and the gas being carried through so large a main pipe, the loss from friction is very small, and the line makes a valuable feeder to the city mains.

But evenwith all three lines, which were delivering into the two cities the enormous amount of nearly 90,000,000 cubic feet of natural gas every twenty-four hours, the company could not keep up with the increasing demand for gas. The company then determined to lay the largest line in the world for the conveyance of natural gas from the wells.

This line, which was finished the first of October, 1887, starts from what is called the northern Murrysville gas field, and taking an almost due western course enters the city at the northeastern corner. The line for the first eight miles is sixteen inches in diameter, is made of wrought iron 3/8 of an inch thick, and tested in the mill to 500 lb. to the square inch, and after it was laid, tested with gas to 300 lb. to the square inch. At the end of the eight miles of sixteen inch pipe, a twenty inch pipe begins, and extends for a distance of six miles toward the city, ending at Station O. This twenty inch is also made of wrought iron 3/8 of an inch thick, and was tested the same as the sixteen inch. At the end of the twenty inch, a twenty-four inch begins, and extends five miles through the city. This twenty-four inch is made of cast iron, and was tested in the mill to 300 lb. per square inch. At a point six miles west of Murrysville, a sixteen inch line was laid, connecting the old sixteen inch line and the new one, and so arranged with gate valves that in case either line broke, the gas could be switched from one line to the other, and the break could be repaired without shutting off the entire line.

The lines deserve more than a passing notice. As the sixteen inch pipe was, at the time the Chartiers Company laid their first line to Murrysville, the largest lap-welded wrought iron pipe that was ever made, so is the twenty inch now the largest lap-welded pipe, and only one mill in the world can make it, and that is the National Tube Works, of McKeesport, Pa. The Converse patent joint has been used on all these large lines, and has given entire satisfaction, the joints being tighter and requiring less repairs than the joints made by screw threads.

This immense line, over twenty miles long, was laid and gas running through it in less than one hundred days from the time it was started. Nothing was slighted that would add to the efficiency, hill tops were cut down as much as twenty-five and thirty feet, all ravines were bridged with iron or wooden trestles, and every precaution taken to make the loss of the gas due to passing abrupt bends and curves as small as possible, and the Chartiers Valley Gas Co. feels to-day that it has a line which is far ahead of any other pipe line that was ever laid, both in regard to size and the manner in which it was constructed.

The four main lines from the gas fields that comprise the high pressure or country system of the Chartiers Valley Gas Co. can deliver into the cities of Pittsburg and Allegheny nearly 200,000,000 cubic feet of gas every twenty-four hours, and this can be done without putting the well pressures excessively high.

The Chartiers Valley Gas Co. has the following number of feet of pipe laid from the well to the city limits:

20	inch	28,363 feet.
16	"	151,962 "
12	"	32,980 "
10	"	60,600 "
8	"	185,683 "
6	"	17,060 "
4	"	2,610 "

Making a total of 479,258 feet of high pressure lines.

DISTRIBUTION OF GAS.

As before stated, the Chartiers Co. draws its supply of gas from three separate and distinct fields. As the gas enters the city it passes through regulating stations where the pressure is reduced, as a higher pressure is carried on the lines from the wells to the city limits than within the city. The appliances for reducing this pressure are shown in Fig. 2.

The gas enters the station on the main line shown in the center of the cut at the top. From this line two branches are carried off from each side, and which are carried back again into the main line. In the center of each one of these branch pipes or arcs a regulating valve is placed, which is so constructed that the pressure is reduced to that required by placing the proper weights on the levers that extend from them. On each side of each of these regulating valves a gate valve is placed in order to shut off the gas from each regulator, in case they should need repairs, and at the same time not interfere with the flow of gas through the other valves.

The number of regulating valves, and their size, is such that there is always one more valve than will give the full capacity of the line. In the main line which passes through the station house in the center a gate valve is placed which is called the by-pass valve. During the ordinary operation of the line this valve is kept closed, but should any accident occur by which it would be necessary to close all the regulating valves, this by-pass valve would then be open and the gas would pass directly through the station. The main line is increased in size at the outlet side of the regulating valves in order to give the gas more volume, and in this way make up for the reduced pressure. The regulating station, shown in Fig. 2, was especially designed for use on the new 16, 20, and 24 inch line from Murrysville, and is the first station of this kind ever constructed. It is far superior to the reducing stations in general use, as the enormous loss from friction in making the gas turn many bends and angles, as is ordinarily done, is in this case obviated. The line, as it enters this station, is twenty inches in diameter, and as it leaves it is twenty-four inches in diameter.

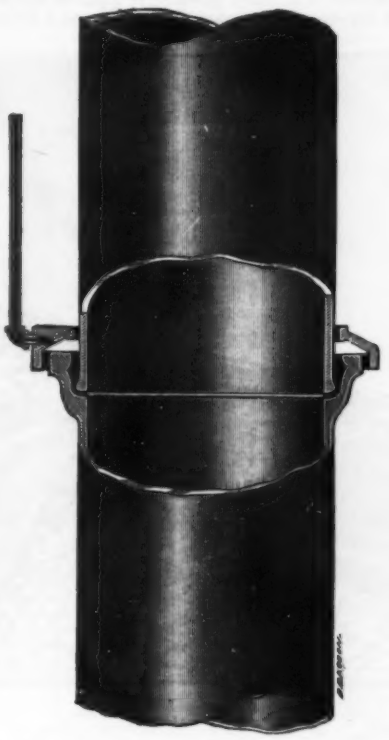


FIG. 4.—SLEEVE AND CONDUCTING PIPE.

The pressure is reduced at these stations from fifteen to twenty-five pounds per square inch, and all the lines that carry this pressure through the city are styled mill supply lines. The twenty-four inch line after leaving this station is laid in an almost westerly direction to Butler Street, which it enters at Fifty-seventh Street, from where it is laid along Butler, Hatfield, Mulberry, Penn, and other streets along the Allegheny River near the shore, where all the large mills are located. This line continues down the Allegheny River to Fifth Street. It is then laid along Fifth Street and Ferry Street to the Monongahela River, which is crossed at the foot of Ferry Street by five ten inch lines, and is connected into the South Side mill supply system on Carson Street, near the Clinton Mills.

The company has similar reducing stations on the south side of the city on Carson Street, near the city line, at the head of Main Street, in the west end of the city, and at the western limits of Allegheny City. At each one of these stations high pressure lines from the wells enter, and after the pressure is reduced, the gas is carried by immense trunk lines all through the manufacturing portions of the city.

From Station D a twenty inch line is laid along Carson Street and Sarah Street to Twenty-sixth Street, at which point it branches into two sixteen inch lines, one of which is laid along the Monongahela River and the other along Mary Street, at the foot of the high hills overlooking the South Side of the city. At Eighth Street these two sixteen inch lines are led into a twenty inch again, which continues on down the city through its entire length to the city limits at the head of Main Street, where our Station F is located, and where this twenty inch line receives a fresh supply of gas from our Hickory field.

From Station K a twelve inch line is laid up through Allegheny City, on the streets parallel to the river, and near all the manufacturing establishments, as far as Lindsay & McCutcheon's mill, where it is connected into the South Side mill system by two ten inch lines laid across the Ohio River.

All these various mill supply lines are connected together at different points in the city, forming one vast system of nearly thirty miles of pipe. This is exclusive of the private house supply lines, which are entirely separate and distinct from the mill system.

On all the mill supply lines of the Chartiers Valley Gas Company a system of carrying away any gas that may leak from the joints is used that far exceeds in efficiency any other appliance used for that purpose. The patent is controlled by the Chartiers Company, and its excellence is shown from the fact that there never has been an explosion of gas on any line of the Chartiers Valley Gas Company within the city limits, nor has the company ever been called upon to pay one dollar for damages arising from explosions within the city. Fig. 3 shows the complete system. It consists in placing a sleeve over every joint in the gas line, first seeing that the joints are absolutely tight under pressure, and having them inspected and passed by the city inspector. This sleeve (shown as it is placed on the joint, Fig. 4) is made perfectly gas tight around the pipe by means of lead or other suitable material. On the inside of the sleeve a space or chamber is left where all the gas that escapes from the joint is collected. Connected with this chamber at the top a small pipe leads off and up to the top of a lamp post situated at the curb. Several of these pipes are led into one lamp post, but each joint of the main pipe has its own separate and distinct escape pipe, which is in no way connected with the others. Each joint on the main pipe is numbered, and its exact distance measured from the lamp post. The escape pipe that leads away from the joint is marked with a corresponding number at the top of the lamp post; so if gas is discovered escaping, by noting the number of the small pipe through which it escapes, the exact location of the leak can be determined.

In addition to the above described system, the Chartiers Valley Gas Company takes the further precaution of putting in its patent broken stone escape system on all lines, whether they are mill supply lines or for house supply. It is done as follows: After the separate pipe escape system has been put on the main, the ditch is filled with earth to the center of the pipe, then a layer of broken stone is thrown in the ditch until it is filled to a height of nine inches above the pipe. The stones are broken to about the size of a man's fist. At every lamp post that has been put up for the separate pipe escape system, this broken stone is filled in to the curb, and made to communicate with the lamp post. Then a layer of tar paper is spread over all this broken stone to keep the dirt from mixing with it, and the ditch is filled up. By this means if any gas should escape through the body of the pipe, it follows this "French drain" and up the lamp post to the open air.

With such a system, it is impossible for any escaping gas to find its way into cellars or sewers, for with a free, uninterrupted opening into the air, it would invariably seek that course in preference to any other; in addition to which, the lamp post creates a draught that tends to draw any leaking gas away from the line.

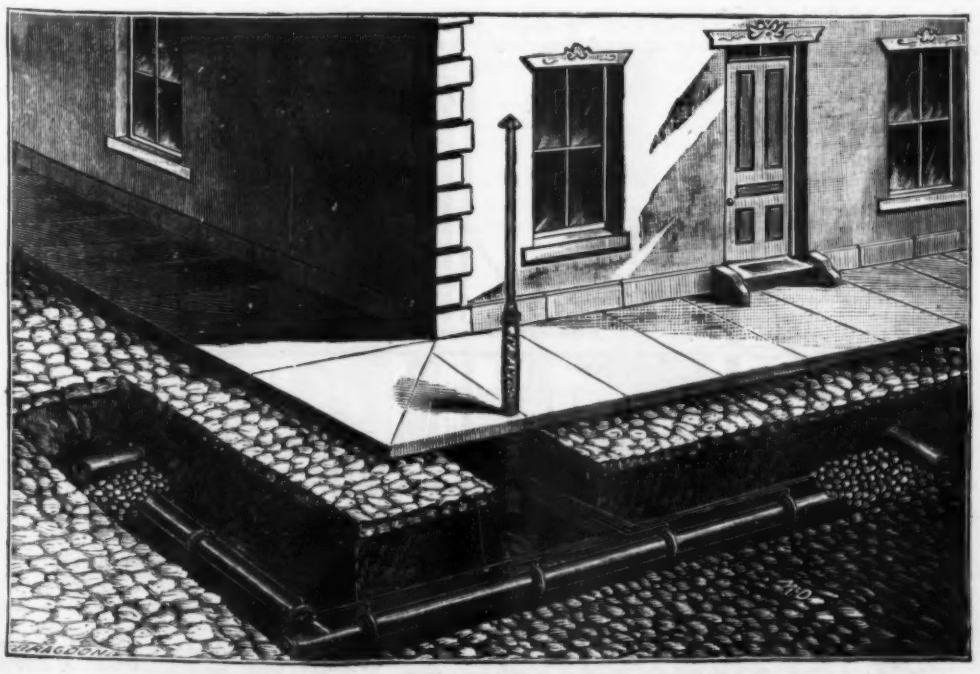


FIG. 3.—MODE OF CONTROLLING GAS PIPE LEAKAGES.

HOUSE SUPPLY LINES.

A gas company's system for supplying its private consumers deserves careful study, since the opportunity for accidents is greater than on the mill supply lines, owing to the vast number of consumers.

There are two distinct systems for supplying natural gas to private houses. The first consists in laying a system of small pipes, generally about 4 inches in diameter, in the streets and connecting these small pipes at certain points with the mill supply lines by regulating valves so set that five lb. of gas is received into, and carried on, the small lines. To reduce this pressure, which is too great to be conducted into a house, a regulating and automatic shut off is put in each house by which the pressure is reduced to about four ounces, which is the proper pressure for gas for burning in private houses. The only possible advantage in this system is that by carrying a high pressure on the house supply lines, much smaller pipes can be used, and second, by carrying this high pressure, each customer is compelled to purchase a certain regulator to put in his cellar, upon which there is no doubt a profit to the gas company.

The great danger in this system consists in the fact that all mechanical devices are apt to get out of order, and especially a machine having the delicate machinery in it, and requiring the nice adjustment, that a regulator for natural gas does. Such a machine when put in a cellar where the people do not understand its operation, nor could take care of it if they did, is apt, and very liable, to get out of order and let the full pressure of the five lb. street main into the house, which would be very dangerous, both on account of the fact that ordinary house plumbing is not put up with the intention of the pipes having to stand that

pressure, and besides the danger from fires left burning at night, should such a strong pressure be put on.

The system used by the Chartiers Valley Gas Company to supply its private consumers consists in laying an entirely different network of pipes from its mill supply system, but connected at different points with these mill lines by means of regulating valves, the same as in the first described system, but it differs in this important point: The Chartiers Company lays pipes to supply the private houses so large that only a pressure of four or five ounces need be and is carried on them. The service pipes are then run direct into the consumer's house, no regulating or other device being necessary, as the pipes themselves carry no greater pressure than is required in the houses.

The valves that control the pressure between the mill and the house supply lines are eight in number, and perhaps will never be more than twelve; and to watch them the company keeps watchmen night and day,

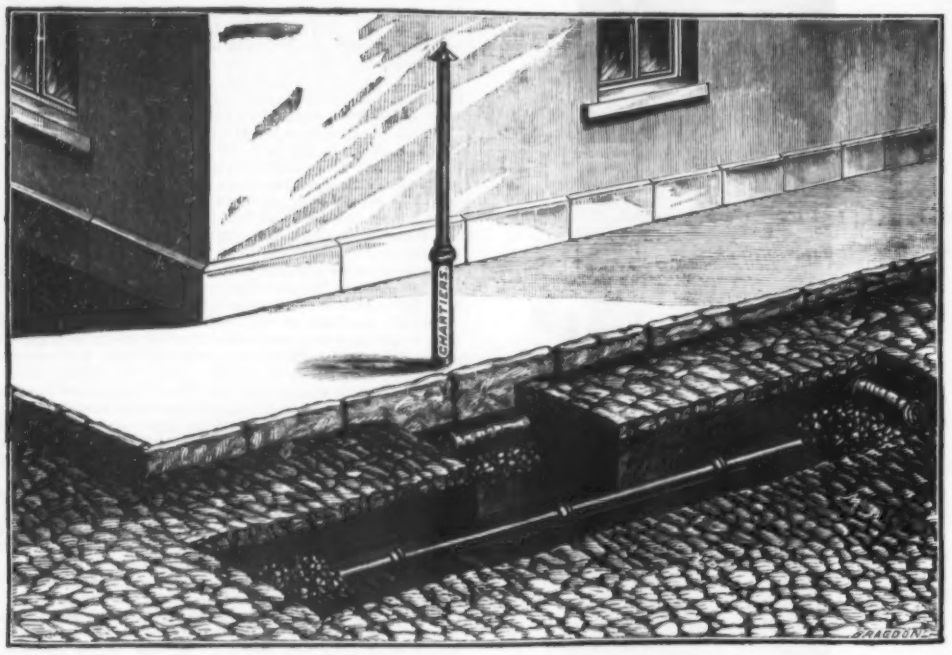


FIG. 5.—GAS CONNECTIONS FOR HOUSE LINES.

whose duty it is to see that these valves are always in order.

On all the house supply lines of the Chartiers Valley Gas Company is placed the broken stone escape system for conducting away to a point of safety any gas that leaks from the joint, although leakage from the house supply lines is very rare, owing to the low pressure carried. A cut of the escape system is shown in Fig. 5, and is the same as the system adopted for the mill supply lines, except that the separate pipes from each joint are left off.

The Chartiers Valley Gas Company has at the present time twenty miles of lines for house supply in the city of Pittsburg, and eight miles in Allegheny City. It also supplies gas for house consumption in the towns of Homestead, Mansfield, Chartiers, and McKee's Rocks.

It is of course the first aim of every gas company to make the conveying and distribution of natural gas as safe to persons and property as is possible by human ingenuity and foresight; and to attain this security, a complete system of patrol is established on all the lines of the company, whether for mill or house supply. The country lines are patrolled during the day and the city lines during both day and night; all regulators between the mill and house supply lines are examined many times during the day and night; all the fittings, valves, etc., used on the lines are made from the company's own designs, and are extraordinarily heavy and strong, and in fact everything is done that can be to insure safety both to the customer of the company and the general public

EMMENSITE, ANOTHER NEW EXPLOSIVE.

SOME trials have recently been made, in New York, of a new explosive named emmensite, and as the results attained were of an exceptionally remarkable character, our readers may be interested in the following details, which we have gathered together partly from the accounts appearing in the New York press and partly from technical explanations specially furnished to this journal by the inventor, Dr. Stephen H. Emmens.

The explosive, in its simplest form, consists of two ingredients, one of which is a new nitro derivative of certain hydrocarbons of the aromatic series, and can be prepared on the large scale by the distillation of coal at a low temperature, while the other is a mineral salt found in certain localities in vast quantities. For special purposes other chemical ingredients are added, but the general character of the compound remains the same in every grade. The ingredients are mixed together by a peculiar though very simple process, which forms one of the principal features of the invention as patented, and the resulting product is a true chemical compound, instead of being merely a mechanical mixture, as in the case of gunpowder and dynamite. Hence the uniformity of action and completeness of explosion which characterize emmensite as compared with other blasting powders; and as it contains sufficient oxygen for the complete combustion of its carbon and hydrogen, and has no nitro-glycerine to be partially vaporized, its use is unattended by the evolution of noxious fumes or poisonous gases.

But perhaps the most singular feature of this new explosive is its capability of being fused. It may be melted and cast into any desired form. When thus treated, a lump of emmensite will burn quietly, producing a very brilliant and smokeless flame which may be made to assume a vivid crimson, blue, purple, green or other hue by the addition of ordinary coloring ingredients to the fused mass before cooling. The production of smokeless colored fires for pyrotechnic, theatrical, and signaling purposes has long been a desideratum, and the experts present at the emmensite trials were of opinion that the new compound fills the bill. Another advantage of the fusibility of emmensite consists in the fact that granulation may thereby be effected, and, by increasing or diminishing the size of the grains, a powder of any desired quickness of action may be produced. Hence emmensite enjoys the distinction of being the only "high explosive" capable of being used in fire arms as well as for rock blasting. The New York experiments conclusively settled this point, for the same sample of emmensite was first tried (in the form of a coarse powder) in a pistol, and proved much superior to ordinary gunpowder as a propelling agent, and then (in the form of a flour-fine powder) was tested against explosive gelatine in shattering iron plates, and did much better work.

The specific gravity of emmensite is 1·8, and is thus higher than that of any other high explosive hitherto employed. This and the perfectly adjusted character of its chemical composition are the principal factors of its explosive power, which, by theoretical computation, is estimated as equivalent to a pressure of 283 tons per square inch, the corresponding estimates for other leading explosives being as follows:

Nitro-glycerine	264	tons per sq. in.
Explosive gelatine	253	" "
Forcite	250	" "
Oxomite	249	" "
Panclastite	203	" "
Gun cotton	198	" "
Dynamite No. 1	144	" "
Atlas B	133	" "
Rackarock	117	" "
Roburite	24	" "
Blasting gunpowder	23	" "

The comparative powers shown by these figures were shown to be correct by many practical tests in the New York experiments. Thus, for example, an iron plate 6 inches square and $\frac{1}{4}$ inch thick was suspended in the air by two loops of cotton thread. A cartridge of $\frac{3}{4}$ inch diameter and charged with 1 oz. of dynamite containing 60 per cent. of nitro-glycerine was placed on this plate, without any tamping, and fired. It simply bent the plate. Another cartridge of equal diameter, and charged with 1 oz. of Nobel's explosive gelatine, tore a similar plate open for a length of 2¼ inches. A third cartridge of the same diameter, but containing only ½ oz. of flour-fine emmensite, dashed a hole 3 inches in diameter right through a plate of equal dimensions to those used in the previous experiments.

It would seem, then, that this new explosive may deserve investigation by engineers and miners, and as the New York tests showed it to be very safe to handle and store, while it is said to be cheaper as well as more powerful than dynamite, it should soon take its place in the first rank of blasting agents. Lieut. Zalinski, of dynamite gun fame, who was present at the tests referred to, has ordered a supply of emmensite for use in the room of explosive gelatine in his shells; and the officials of the Panama Canal Company, after special experiments, have intimated to the Emmens Chemical and Explosive Company that emmensite will forthwith be adopted by several of the principal contractors on the Isthmus.—*American Engineer.*

[SANITARY NEWS.]

THE QUARANTINE SYSTEM OF LOUISIANA.

By JOSEPH HOLT, M.D., President Board of Health, State of Louisiana.

METHODS OF DISINFECTION PRACTICED.

IN describing the methods of disinfection used in the quarantine of Louisiana, it is necessary first to examine the system itself synthetically.

There are three maritime approaches to New Orleans, the Mississippi River, which is the central and main avenue; the Rigolets, thirty miles to the eastward, a narrow strait connecting Lake Pontchartrain with Lake Borgne and the Gulf of Mexico; and the Atchafalaya River near its debouchment into the bay of that name and Mexican gulf, eighty-two miles to the westward.

On account of the character of shipping coming through the two lateral approaches, "light in tonnage and mostly from domestic ports," the Rigolets and Atchafalaya are completely closed by a proclamation of forty days' detention against all vessels from quarantine ports, compelling such to seek the Mississippi as the only available route to New Orleans. This is done in order to avoid the immense expense of keeping up three completely equipped stations, and to concentrate at a single point the fight against infection.

The quarantine in the Mississippi is a system composed of three stations, the first of which is an advance guard inspection, situated at Port Eads, one hundred and ten miles below New Orleans, where the waters of South Pass are jettied into the gulf.

When an inward bound vessel comes into the offing, she is immediately boarded by a thoroughly skilled medical officer, and a careful inspection is made of her sanitary record and present condition.

If from a non-quarantined port and all is well, she is given *pratique* and goes into the city. If from a quarantined port, but presenting a clean health record of voyage, and no evidence of sickness of a dangerous or doubtful character, she proceeds to the upper quarantine station, situated on the left bank of the river, seventy miles below the city, where she is subjected to a full course of sanitary treatment, and is detained such length of time, not exceeding five days (except in rare instances, wherein further observation may be deemed necessary), as the board of health may provide.

If, upon inspection of a vessel entering the river, she is found to be foul—that is, showing positive or suspicious evidences of infection, either in a person then ill or in a foul health record of voyage—she is at once remanded to the lower station, located on Pass a l'Outre, an unused outlet of the Mississippi, one hundred and three miles below the city. The sick, if any, are at once removed to the hospital, where every provision has been made for them. The vessel, with the well on board, is dropped down stream a few hundred yards and anchored. In the mean time the quarantine tug boat with its complete disinfecting outfit has been telegraphed for and speedily arrives from the upper station, when the work of disinfection begins and does not cease until the vessel has been subjected to the most vigorous application of the solution of the bichloride of mercury, her atmosphere, below deck, completely replaced with one heavily charged with sulphurous oxide, and every article of baggage and ship's wardrobe has been saturated with the mercuric solution.

A ship known to be infected with one of the three

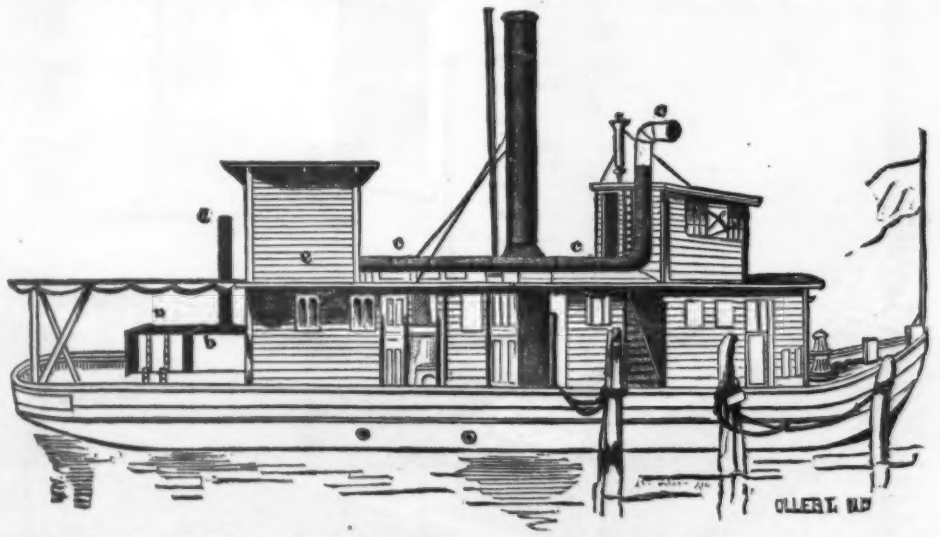


FIG. 1.—TUGBOAT WITH FUMIGATING APPARATUS.

a. Furnace. *b.* Reservoir for reception of gas. *c.* Discharge pipe, conveying gas to ship's hold. *d.* Escape pipe for gas when fan is at rest and sulphur is burning; closed by a valve when fan is in motion. *e.* House protecting from weather the machinery for driving fan and containing accelerating gearing.

great pestilential diseases—small-pox, cholera or yellow fever—can stand and must endure extraordinary treatment, even if clothing is wetted and some articles damaged. "They who go down to the sea in ships" assume the perils of the voyage, among which is this occurrence of finding themselves on an infected vessel and being compelled to undergo a cleansing, for they have no right to bring their perils ashore and endanger others.

Thei mmediate segregation of the sick and the well, and disinfection of the ship and all baggage (in the case of a cholera-infected vessel extended to the disinfectant washing out and refilling of the water tanks, destruction of the food supply and revictualing the vessel), constitute the treatment of an infected vessel at this station. The ship, together with all on board, is held for observation a period of ten days, or more, according to circumstances, when she is released and proceeds to the upper station, where the processes of sanitary treatment are repeated, with the addition of the use of moist heat applied to baggage, ship's apparel, etc. (which latter process will be described hereafter), and the vessel is then allowed to proceed to the city. This course of treatment at the upper station, while probably unnecessary, is enforced purely as an extraordinary precaution.

Inasmuch as infected ships are the exceptions, but inasmuch also as the board of health will take no risk in the case of vessels from known infected or suspected ports, regardless of bills of health, the vast majority of vessels are treated at the upper station. Arriving at this station, the vessel is brought alongside the wharf. All on board—officers, crew, and passengers—are at once sent ashore, where they find ample accommodation, in commodious shelter, provided for their entertainment during the time occupied in the sanitary treatment of the ship and all baggage. As soon as this is completed they are permitted to return aboard ship, where they remain under observation during the prescribed period, determined by the remoteness or nearness of the port against which these precautions are taken. The object of this brief detention for observation, after the sanitary treatment of the vessel has been completed, is to allow for a probable outbreak of an infectious disease already incubating in the system of any one on board.

As an essential part of the service there is a tug boat of sufficient power to move a sailing vessel to or from the wharf. In addition to this requirement, this board is equipped with a complete outfit for generating and applying germicidal gas for displacement of the entire atmosphere within the ship, transported, perhaps, directly from some infected port. In the hold of this tug is constructed a wooden tank of two thousand gallons capacity, to hold the bichloride of mercury solution for the treatment of vessels in the lower quarantine, as described. This tank is furnished with a steam pump (made of iron on account of the greater resistance of that metal to amalgamation) supplied with three-quarter inch rubber hose. (See Fig. 1.)

In the sanitary treatment of a vessel in quarantine, there are three processes of disinfection concurrently applied.

FIG. 2.—View of disinfecting wharf, showing tug fumigating vessel. Elevated tank containing 8,000 gallons of bichloride of mercury solution, three leads of hose from tank to ship. Gangway leading to building containing superheating chamber.

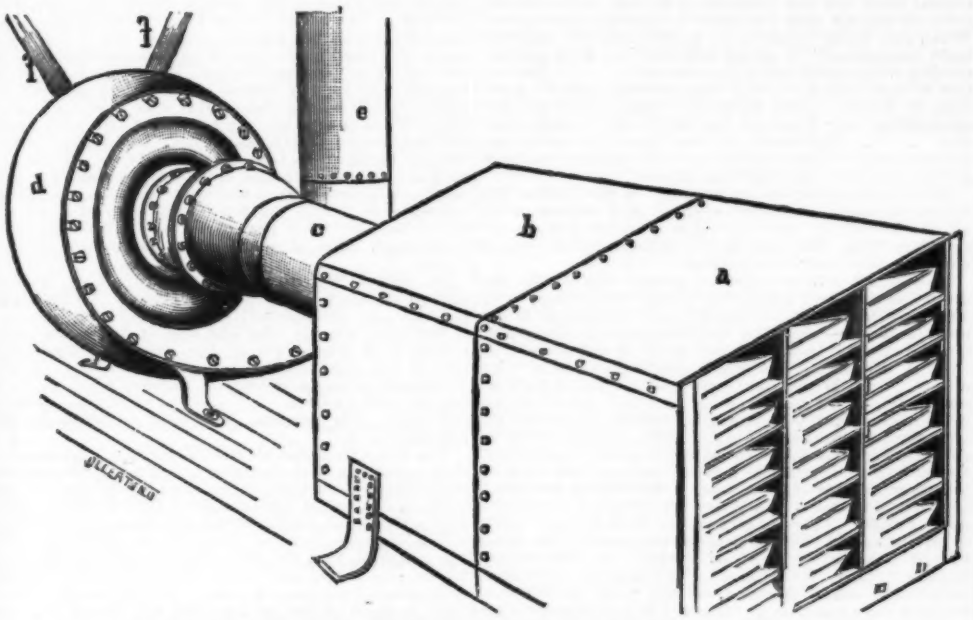


FIG. 3.—FUMIGATING FURNACE, RESERVOIR, AND EXHAUST FAN.

a. Furnace of cast iron, ⅛ inch thick, 3 feet wide, 3 feet long, 2 feet high. Upper and lower plates grooved for reception of partitions, and sides shouldered for same, as shown in Fig. 4. *b*. Reservoir, No. 10 iron, same dimensions as furnace. *c*. Exhaust pipe connecting reservoir and fan. *d*. Exhaust fan, Sturtevant's No. 29, Medium Planing Mill Exhauster. *e*. Discharge pipe from fan, made of No. 20 galvanized iron. *f*. Driving belt. Height of legs supporting furnace and reservoir, 10 inches. On reservoir at letter *b* should be shown a 12 inch opening for escape pipe as indicated (*d*) Fig. 1.

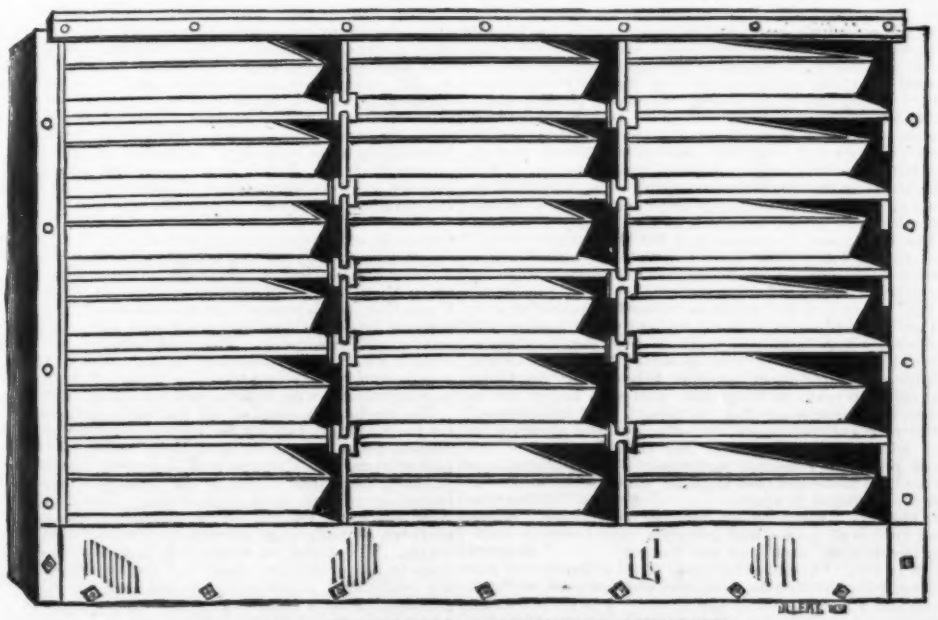


FIG. 4.—FRONT VIEW OF FUMIGATING FURNACE.

Dimensions of each compartment, 12×3¼ inches. Pans of cast iron ⅛ inch thick, 1½ inches deep, 11 inches wide, and 2 feet 10 inches long, outside measure. Free space above pan about 1¾ inches.

APPLICATION OF BICHLORIDE OF MERCURY.

The first is the wetting of all available surfaces of the vessel, excepting cargo, but including bilge, ballast, hold, saloons, forecastle, decks, etc., with a solution of the bichloride of mercury, made soluble by an equal weight of muriate of ammonia, in the proportion of one part to one thousand of water.

The idea of using this agent as a disinfectant in "municipal and maritime sanitation" suggested itself to me while reading the chapter on "Wound Disinfection-Antiseptics" in the volume entitled "The Treatment of Wounds," by Lewis S. Pilcher, M.D., containing an account of the experiments of Dr. George M. Sternberg, with a table of chemical agents and their relative germicidal strengths (at the head of which stands the bichloride of mercury) and also a table of the results obtained by Koch in Berlin, 1881, and by Schede and Kummel in the Hamburg general hospital in the same year.

The board of health immediately indorsed the idea and ordered the adoption of the bichloride of mercury, as explained in the following letter:

NEW ORLEANS, July 17, 1884.

DR. THOMAS Y. ABY, Resident Physician,
Mississippi Quarantine Station:

Dear Sir: Because of the signal failure of carbolic acid as a disinfectant and prophylactic agent after a trial more fair and extended than has ever been allowed any other; because of its excessively offensive odor and the oppressive and sometimes mischievous effects of its fumes; because of the low order of the commercial acid as a germicide and the considerable expense involved in its use, you are hereby requested to discontinue its application. In its stead I have ordered to your station two packages of bichloride of mercury and muriate of ammonia, the latter to act as a solvent.

In its preparation for use take five and a half ounces of each and dissolve in a half gallon of water; add this to forty gallons of water in a cask. I have sent three large watering pots, with a fine rose or spray. Your men can quickly wet down a ballast pile and all available surfaces of a ship, and it needs no repetition when once thoroughly applied.

The advantages of this agent are briefly these: The mercuric bichloride stands pre-eminently above all chemicals as a universal germicide. Not only are definite organisms immediately destroyed, but all protoplasms and albuminoids are devitalized by it. It is efficient to accomplish this work when applied in a solution so weak as not to be recognized except by chemical reagents. It is devoid of color or smell. It does not poison the air by vaporizing, but adheres in an innocuous form to the surfaces upon which originally applied. Its cost is about one-eighth that of carbolic acid.

I feel that this transition is quite as much of a relief to you, my dear doctor, as to the afflicted people on shipboard, who must surely suffer severely from the stifling fumes emanating from carbolic acid applied to surfaces heated by a July sun, as the people of this city can testify to their terrible cost!

The position of persons confined on shipboard under such circumstances, particularly in the instance of women and children as passengers, as related by yourself, must at times be most distressing. The board of health heartily joins with you in the satisfaction and sense of relief afforded by this change, which is an important step in the great work of humanizing our quarantine. I remain, with great esteem, yours very truly,

(Signed) JOSEPH HOLT, M.D.
President Board of Health, State of Louisiana.

The bold adoption of this poisonous agent in domestic, muncipal, and maritime sanitation at once called forth a flood of most gloomy forebodings of fearful effects upon the human system.

Our declaration at that time is confirmed by an experience of four years' trial on an immense scale, that our standard solution, as used in sanitation, is absolutely harmless to persons unless swallowed, it matters not how extensive or constant the contact. The only objection we have yet discovered is that certain articles, particularly blankets and flannels, treated by the solution sometimes become spotted, and colors liable to "run" when wetted, suffer; but unlike all other chemical agents applied as disinfectants, the textile itself is in nowise injured.

Recapitulating its merits: Being colorless, stainless (except as stated), odorless, not injurious to fabrics, perfectly safe to handle for months at a time, easily applied, and exceedingly cheap, it is impossible to imagine a substance more efficient and as free from objection in practice. It is indeed the key unlocking difficulties otherwise insurmountable, and rendering practicable in municipal and maritime sanitary work the efficient execution of scientific requirement. The amalgamating powers of the mercuric salt presented many serious obstacles in the contrivance of an apparatus for its application, all of which have been overcome without sacrificing simplicity, efficiency, or economy.

Immediately adjoining the quarantine wharf, and near its water edge, is constructed a heavy framework of piles, each twelve inches in diameter. This structure has an ample base, is pyramidal, and forty-five feet in height above mean level of the river. On top of this is a circular wrought iron tank, capable of holding eight thousand gallons of the mercuric solution. (See Fig. 2.)

In order to prevent contact of the latter with the iron the interior of the tank is painted over with three coats of red lead and two of paraffine paint. The top of the tank is closed by a secure cover to prevent access of light to the solution. This, together with the general exterior, is painted black.

On the top of this cover is placed centrally a sixty gallon wooden cask, in which is dissolved the mercuric salt, which is then emptied into the tank through a wooden faucet. Seventy pounds are used for one charge.

In the tank near the lower edge are three heavy galvanized iron faucets, to each of which is screwed a lead of three-quarter inch, four ply rubber hose, the farther ends of which lie on the wharf. These are lengthened by additional sections to reach any part of the largest vessel. To the far extremity of each hose is attached a short, wide nozzle, provided with a stop cock. During disinfection, all three are simultaneously used, fore, aft, and amidship.

For spraying, we use a perforated. heavy block tin rose, four inches across the face, similar to an ordinary watering pot spray. These are made with a shank about six inches long to fit snugly into the open end of the pipe. On a single vessel we average fifteen hundred gallons of solution, but often use three thousand. The process requires from thirty minutes to two hours, according to circumstances.

SULPHUROUS OXIDE FUMIGATION.

As soon as the men have completed the work of "bichloriding" below decks, the fumigating pipe is then extended from the quarantine tug boat lying alongside (See Figs. 1 and 2.) It is lengthened by sections, being fitted together like stove pipe, and conducted down a convenient hatchway to the bottom of the hold or as near the keelson as possible, preparatory to the fumigation of the entire vessel (and cargo if any) with sulphurous oxide. In the case of a sailing ship, one hatchway gives access of the sulphurous gas to the entire hold; but in large steamers the hold is subdivided by bulkheads into two or more distinct compartments, which must be treated separately. In undergoing treatment, the cargo is not disturbed, except when the removal of bags of coffee is required, to permit the passage of the fumigating pipe, which is twelve inches in diameter, down into the dunnage at the bottom of the cargo.

I have given explicit instructions to coffee importers, whereby the expense of removing bags to make this well or shaft through the cargo may be avoided. It is necessary to have an open framework shaft, allowing a clear inside space of fifteen inches, placed in the center of the main hatch in a sailing vessel or in the center of each hatch in a steamship having bulkhead compartments. The framework of this shaft is set before loading and should be cut flush with the top of the cargo. This simple arrangement avoids all handling and delay.

When the connections are made and the fumigating pipe is arranged, the fan on the tug boat is started and the process of displacing with sulphurous oxide the entire atmosphere within the ship begins. The length of time required to complete the fumigation varies from thirty minutes to three hours, according to size of vessel, number of compartments, etc.

The quantity of commercial roll sulphur used varies from one hundred to seven hundred pounds per vessel.

The apparatus invented for rapidly evolving and supplying the germicidal gas consists in a battery of eighteen furnaces, each supplied with a pan to contain the sulphur during combustion. These furnaces open into a common reservoir, to the farther end of which is connected a powerful exhaust fan. (Sturtevant's No. 29.) (See Figs. 3 and 4.)

The gas drawn by the fan is driven into a twelve inch galvanized iron pipe, through which it is conducted over the side and down the hatchway of the vessel into the bottom of the hold.

The gas, as it is driven into the vessel, is quite hot, but would extinguish rather than create fire. The outflow should not impinge directly against bags of coffee or bales of textiles, if it can be avoided, in order to prevent formation of sulphuric acid and some slight injury therefrom at that point. In treating coffee, and for convenience in some other instances, the vertical lead of pipe into the hold is made of asbestos cloth, closely and heavily woven for our purpose. Every opening is closely battened during the process and remains so for at least eight hours after it is discontinued.

THE MIND CURE.*

By MARY J. FINLEY, M.D.

IN a little pamphlet entitled "Historical Sketch of Metaphysical Healing," by Mary Baker G. Eddy, President of the Massachusetts Metaphysical College, the author tells us that in the year 1866 she discovered the "science of metaphysical healing," which she "afterward named Christian science." She declares that she was led to this discovery by her "immediate recovery from the effects of an injury caused by an accident, which neither surgery nor materia medica could reach." Other writers on mind cure declare that Mrs. Eddy obtained not only her ideas, but her first manuscripts as well, from P. P. Quimby, under whose influence she came in 1862.

Whatever may have been its origin, Christian science, or the mind cure, is now the most popular craze in some of our large cities; and, like spiritualism, like the skating rink, and like the airs of "Pinafore," will probably sweep over the country until it has penetrated to the remotest hamlet, and may found a school of medicine as popular as that of Hahnemann. Such being its present status and future possibilities, it cannot be without interest to the medical profession to examine into the theories and practice of its advocates. A system of metaphysics and religion is so closely interwoven with their theory of health and disease—their physiology and pathology—that it is impossible to give the latter without a brief statement of the former. Dr. W. F. Evans, a leader of one of the sects, and probably the most philosophic mind among them, in the preface to his latest work, "The Divine Law of Cure," says that this volume, to which all his other writings may be considered as introductory, is "an attempt to construct a theoretical and practical system of phrenopathy, or mental cure, on the basis of the idealistic philosophy of Berkeley, Fichte, Schelling, and Hegel." Mrs. Eddy disclaims indebtedness to these philosophers, and declares her metaphysical theory, as well as its application to the cure of disease, to be an original discovery or "revelation." Her philosophy, however, presents nothing new, and in its fundamental features is identical with that of Dr. Evans—which might be called a materialistic idealism, and bears about the same relation to the subtile reasoning of Hegel that a cheap chromo bears to one of Raphael's Madonnas.

The efficient cause and active force in nature is God; not a personal deity outside of it, but the force permanently resident in nature. This divine element is the vital germ from which our existence springs. All conscious being is a part of God. "All the millions of the race are but the rising into individuality of the ocean of being, but they never lose their connection with it."

"The incarnation is not a solitary miracle, but a universal fact." The body is merely an outward manifestation that the soul forms about itself. "The body neither lives nor dies. It lives from the spirit, and this from the Deity." Material nature exists only as the mind takes cognizance of it, and has no separate reality. There is no reality but spirit. Everything outside of us is but a dream of the spirit within us. Literally, "This world is all a fleeting show, for man's illusion given."

Mrs. Eddy says: "All sensation is mind, and mind is God. Hence there is but one mind, and this one is infinite, supplying all mind by the reflection, not subdivision, of himself. . . . God is supreme; is mind; is principle, not person; includes all, and is reflected by all that is real and eternal; is spirit, and spirit is infinite; is the only substance; is the only life. Man was and is the idea of God; therefore mind can never be in man. Divine science shows that matter and mortal body are the illusions of human belief, which seem to appear and disappear to mortal sense alone. When this belief changes, as in dreams, the material body changes with it, going wherever we wish and becoming whatsoever belief may decree. . . . The entire mortal body is evolved from mortal mind." After this, it follows quite naturally that "food neither strengthens nor weakens the body—mind alone does this. . . . The truth is, food does not affect the life of man." However, we are not advised to stop eating until we "gain more goodness."

Health, according to Dr. Evans, "is the divine life within us coming to a free activity and expression in all our voluntary powers;" it is a divine gift, an inspiration from God, and in the philosophy of Jesus is viewed as identical with religion.

Disease arises from a lack of proper union with the divine nature, and consists in a false conviction: "A wrong conception and belief ultimate themselves in the body in disease—acute if it be a temporary mental state, and chronic if it be a confirmed mode of thinking." A chronic disease is "a morbid steadfastness of a false idea. . . . When one says that he has a pain in some part of his body, as in his hand, his head, or his stomach, that is a phantom, for the body has no sensation, no feeling." A mind attacked by a belief in rheumatism gives a knee joint red, hot, swollen, tender, and painful, and runs the general temperature three or four degrees above the normal. "The bodily trouble," says Dr. Marston, "is a reflection or effect of lack of mental ease." There is certainly a concomitant "lack of mental ease," but the general impression has been that it is an effect, and not a cause, of "the bodily trouble." Mrs. Eddy says: "Sickness is a belief, a latent fear made manifest on the body in different forms of inflammation or disease. If you believe in inflamed or weak nerves, you are liable to an attack from that source. You will call it neuralgia, but I will call it illusion." Such being the etiology, pathology, and semeiology of disease, the diagnosis is easy and the prognosis always favorable. "No one ever dies of what is called disease. . . . It is only when faith, hope, and imagination lose their hold upon the organic structure and the soul relaxes its grasp upon the body that it yields" (Evans).

Old age and death—those dreaded specters of humanity—are indeed phantoms only of mortal mind. Wrinkles, silver locks, second childishness, "sans teeth, sans eyes, sans taste, sans everything," are avoidable evils. Here, in America, is found at last that fountain of perpetual youth so vainly sought by its early explorers. "By keeping the mind young we have a perfect guarantee for continued youthfulness of body. This new system will make us younger at seventy than at seventeen" (Baldwin). Let us believe ourselves young, beautiful, healthy, and immortal, and so we are. "For whatever as to the bodily condition we think to be true, either by a spontaneous impulsion or by a tenacious volitional effort, becomes to us a reality" (Evans).

The treatment of disease has for its primary object the eradication of the false belief in the existence of disease and pain. This is sought in various ways by the leaders of the different sects.

Mrs. Eddy and her disciples discard all material aids: "The principle and rule of metaphysical healing are spiritual. Any material method whereby to demonstrate it is a departure from science. The use of drugs, hygiene, manipulation, alcohol, tobacco, or anything but mind to make or keep man well and happy are so many conspiracies against his health and happiness." They rely entirely upon the effect of her theories on the mind. The perusal of her books is one of the most powerful remedial agencies: "My publications alone heal more sickness than an unconscientious student can begin to reach. . . . Science" (otherwise her theory) "saith to all manner of disease, 'Know that God is all power and presence, and there is nothing beside him,' and they are healed. . . . Science saith to Fear, 'You are the cause of all sickness, but you are a self-constituted lie, darkness, nothingness, 'without hope and without God in the world;' you do not exist, and have no right to, for 'perfect love casteth out fear.' . . . Science reveals the great fact that suffering exists as mortal mind only, for matter has no sensation and cannot suffer. If you rule out every sense of disease and suffering from mortal mind, it cannot be found in the body matter. . . . Demonstrating the unreality of evil destroys it."

Dr. Evans does not entirely discard the use of drugs. He considers all curative agents as "of the nature of a sacrament, a means of grace," and thinks that "the best device for giving faith a material foothold is found in the dilutions and triturations of homeopathy," but "in the human soul reside all the healing virtues and potencies that can be found in medicinal plants and minerals. . . . Their curative properties are something in their spiritual essence which answers to some energy of the soul;" therefore, "by a voluntary and intelligent use of faith and imagination we can effect a cure of disease in ourselves and others." Pain is to be relieved by resolutely putting out of mind: "A pain, if it is not thought of is not *felt*. It is thus made a nihility, a nothingness. . . . When we think of it, it passes from nothing to something, for it is only by this that it comes to have any reality to us. Disease without this would be as nothing, for it is only a wrong way of thinking, or, if you prefer it, a false belief. Banish it from thought and it no longer exists." Make the patient believe that he is free from disease and he is cured, for "to be unconscious of a thing is all the same as if it were not. To bring disease into the realm of unconsciousness is to make it unreal; in other words, to cure it." "That of which we do not think has to us no existence. . . . There are many well attested facts to show that men in the ardor of battle receive wounds of a serious nature without being aware of them until a considerable lapse of time." It naturally follows that the wounds did not exist "until a considerable lapse of time" after they were received.

If the patient is not able to throw off the thought of disease, the physician must aid him. This may be done by mental treatment, in which the patient is made to "fix his thought with expectant attention upon the effect to be produced. In addition, the physician thinks the same effect tranquilly and strongly wills it, and believes and imagines that it is being done." At the same time the healer silently goes over a form of "mental argument," in which he may call the disease by name. Various formulæ for these "mental treatments," each claiming to be infallible, are sold for good round sums by the leading healers to young practitioners. The belief of the healer may be communicated by words, but a more spiritual way is by touch, and a still more interior mode of communication is by the eye. The "cogitative gaze" is used by many of the healers, who silently bestow it upon their patients for fifteen minutes at a time. But even this is not essential. When the patient is passive, with his eyes closed, and in sympathy with the healer, the latter can transfer his thought to him at any distance. There is a subtile spiritual principle constantly emanating from us which forms a sort of atmosphere about us. We can concentrate this in the touch, and impress it on any individual, or to any part of his body, or we can direct it through miles of space, even across the Atlantic Ocean.

Dr. Evans recognizes the reconstructive force in nature in language almost orthodox: "This *vis reparatrix*, or reconstructive force in nature, ... is the only remedy that can heal or relieve the injury—heal if it comes within the range of possibility, and if not, alleviate the suffering. . . . . *We can assist and greatly accelerate its curative action by thinking in concert with it.* . . . Our thoughts, our faith, our fancy, our remedies, can only be tributary and auxiliary to it."

The first thing that strikes the mind in glancing over this system is that—leaving out of sight the religious and metaphysical side—the theory of disease, its production and relief, here taught is that which is generally accepted as correct in regard to the manifestations of one disease—hysteria—and it is impossible to avoid the suspicion that the large majority of the cases upon whose cure this system bases its pretensions occurred in hysterical men and women. The second thought is that, in spite of the intimacy of the phraseology employed, there is no essential connection between the theology and philosophy of the system and its principles of medicine. The principle of the influence of the mind on the body, as stated by Dr. Evans in one place, may be accepted by the most regular of the regulars: "There can be no doubt of the influence of a *fixed morbid thinking* in the generation of a diseased action in the bodily organs, nor of the power and importance of a sound mental activity in originating and accelerating a cure."

John Hunter said, "As the state of the mind is capable of producing a disease, another state of it may effect a cure." Indeed, in the language of a popular text book on physiology, "The influence of the mind in the production, aggravation, and cure of organic diseases is matter of daily observation;" we have all seen striking illustrations of it. It is admitted in every work on practice, and is most forcibly presented in the fascinating work of Tuke ("Influence of the Mind upon the Body"). Yet it is possible that this principle has not yet received proper attention at the hands of the regular profession.

Since we have absorbed the something of truth presented by every exclusive system of cure that has heretofore arisen, may we not accept from the mind curers a wider application of this truth? Upon this, and not upon their theory of existence, depends their success. Upon this has depended the success of every system of medical humbug that has come and gone in the past, or that still flourishes. The vast number of cures of disease which have occurred in all historic times by means purely psychic prove the power of this influence in conjunction with the *vis medicatrix naturæ*.

The medical systems of all barbaric nations depend for their efficacy largely on mental impressions. Voodooism owes its terrors and their relief to the same powerful cause. Chinese and Japanese medicines apparently owe their effects to the thought of the concentrated horrors of their ingredients. The tragedies of New England, during the witchcraft craze, are vivid pictures of sufferings caused and relieved by mental states. The belief in witchcraft lingers still in a mild form in the mountain valleys of Pennsylvania, and in my childhood I knew of an old woman who could promptly relieve burns by "blowing the fire out," and cure erysipelas by "saying words over it." In England, for centuries, scrofula was healed by the royal touch. When mesmerism occupied in the popular fancy the place now held by "Christian science," numerous

* Read before the North Central Ohio Medical Society, September 30, 1887.

cures were attributed to it. Spiritualism, which promised to revolutionize society, professed also to heal all diseases. We have had water cures, and steam doctors, and magnetic healers, and Indian doctors, and manipulators, and homeopaths, and each and all have had at some time a "boom."

Modern miracles of healing must be classed among cases of bodily disease relieved through mental impression. Allowing that many of the cures claimed have been only temporary alleviations, that many cases diagnosed as serious or fatal diseases have been slight functional derangements, or forms assumed by those skillful conjurers hysteria or hypochondria, the fact remains that many suffering invalids have been permanently relieved and restored to health after medical skill had failed to benefit them.

At the time when sacred relics played so large a part in the history of the religious world, their touch was a recognized agency in the cure of disease. The prince in Longfellow's "Golden Legend," who "was healed in his despair by a touch of St. Matthew's sacred bones," was only one of thousands.

Many priests have been famous as miraculous healers. The cures wrought by several in the present century are numerous and well authenticated. Pilgrimages to noted shrines have been in recent times undertaken for the relief of bodily ailments, much more frequently than for spiritual improvement. This is especially true of the shrines of Mariazell in Austria, Lourdes in France, and Knock in Ireland. These shrines count their yearly visitors by tens of thousands, many thousands of whom return to their homes rejoicing in the relief which they sought.

The "faith cure" is of comparatively recent date, but large numbers of intelligent people have been relieved of all sorts of ailments by "laying on of hands, anointing with oil, the prayer of faith." Institutions have been founded for the treatment of disease by these means. "There are over thirty 'faith homes' in America to-day. In England and on the continent of Europe can be found a large number, some of them commodious institutions, with a history of many decades of years."

The Mormon elders claim the power to heal the sick by prayer and the laying on of hands, and their success has been in proportion to the confidence in their assertions.

The one thing in common in all these cases is the powerful impression made on the mind, arousing confident hope and directing an intense expectant attention to the diseased part. The claim to some power, occult, mysterious, supernatural, whereby disease shall be overthrown, is used to produce the impression. The mind curers alone proclaim the fact that the relief obtained is through the power of the mind over the body. And this truth thus implanted in the public mind will bear good fruit when the eager acceptance of their fantastic idealism shall have become a curious bit of social history.

The immense number of cases of disease relieved by the influence of the mind, and the strong probability that the same influence is a powerful factor in the causation of the great epidemics that have devastated communities, as well as its undeniable agency in developing the varied forms of hysteria and hypochondria, render it a subject worthy of the careful study of the profession. The investigations now being made of the phenomena of hypnotism may eventually throw a flood of light upon this subject. It would seem that, in these cases, the imagination plays some such role in the normal condition as suggestion performs in the hypnotic state.

How the mind acts upon the cells of the gray matter of the cerebrum, and how the nerve force affects the physico-chemical action in the general tissue cells which determines growth, waste, and heat production, are two points that must be further elucidated before the real physiological action of the real mind cure can be written.

However wide may be the chasm between an intellectual state and the metabolism of the cells composing a bunion, there is a material bridge connecting them. Consciousness has a physical basis in the gray matter of the brain. From this physical side thought is a force liberated in the metabolic changes of the nerve cells. In the action and reaction of the mind and its material organ the peculiar force of the nerve cell is set free and projected from cell to cell, from center to center, and from centers to periphery. While the ordinary action of the mind in and through nervous matter has no appreciable effect upon the general system, any extraordinary action may send its rebound to the remotest nerve fibrils, and since every tissue and organ of the body lives and functionates in obedience to the nerves supplying it, every part feels the mental shock; fear breaks in upon the system of the beating heart, pales and roughens the skin, dilates the pupil, and sets the calm muscles in a quiver.

Of the ordinary action of the internal organs of vegetative life the mind does not take cognizance, but a disordered action quickly sends a warning note to consciousness; conversely, morbid mental states interfere with the orderly action of the vegetative organs.

Depressing emotions, long continued, lower the tone of the nervous system and the general nutrition of the body. Peculiar mental conditions may so powerfully affect the nervous apparatus controlling nutrition as to bring about structural changes in a very short time. In the relief of diseased conditions through mental impressions, the concentration of nerve force, and its projection along a certain line of nerve fibers caused by the intense expectant attention directed to the suffering part, determines in the affected region a new and vigorous activity which quickly restores it to the normal condition. When the trouble is central in origin and functional in character, the morbid change being in the forces evolved rather than in the tissues evolving them, the remedial action is probably direct. When the trouble is local, involving structural changes, the effect may be produced through those trophic fibers the existence of which, though not clearly demonstrated, is well established; or through the vasomotor system. The latter, by dilating or contracting the capillary vessels, regulates the force and rapidity of the blood current through a part, the amount of plasma transuded, and the extent of absorption, and thus powerfully influences the rapidity of tissue reproduction, or of its disintegration, and the absorption of the products of its waste.

While our knowledge of physiological processes is too limited to enable us satisfactorily to explain the mode in which the thought acts to produce or remove morbid physical conditions, enough is known to show the manner in which it possibly may act, and the fact of such action is well established.

When this fact shall be recognized by the general public, some other proof than the ability to cure real or imaginary ills will be required before a new theory or doctrine can find acceptance, and the popularity of medical, psychic, and religious humbugs will decline. —*Medical Record.*

CHEMICAL AND ALLIED INDUSTRIES.*

By WATSON SMITH, Lecturer in Chemical Technology in the Victoria University, etc.

BEFORE proceeding to describe some illustrations of the results of chemical research of more modern date having a direct bearing on the chemical industries, a report on this, probably the most complete exhibition of objects illustrative of the progress, advance, and present position of the chemical industries that has ever been brought together, with a description of certain interesting relics of chemical and physical discovery that have had the most important influence on the growth of chemical science, and hence on the development of chemical industry, will be desirable.

Dalton's Apparatus.—To commence with scientific celebrities belonging to Manchester, there is a most interesting selection of the apparatus employed by John Dalton in his classical researches. Here one may see how the most homely utensils are made useful for doing the highest class of scientific work, and how so humble an instrument as an old fashioned penny earthen inkpot or a soda water bottle may be rendered classical. The MS. of the "Principles of Chemistry," with the original table of atomic weights as first determined by Dalton, will be to chemists objects of the deepest interest.

Joule's Original Heat Apparatus.—Dr. J. P. Joule, F.R.S., has lent for exhibition the very apparatus with which he determined the mechanical equivalent of heat. It consists of a small iron cylinder furnished with a central shaft and agitating apparatus, and a cover fitted with holes for the end of the shaft and for a thermometer with which to measure the rise of temperature produced in the conversion of mechanical energy into heat. The important result attained by Joule he expressed thus: The actual quantity of heat developed by friction is dependent simply on the amount of force expended, without regard to the nature of the substances rubbed together, and the numerical conclusion deduced was that the quantity of heat capable of raising the temperature of 1 lb. of water by 1° F. requires for its evolution the expenditure of a mechanical force adequate to lift 772 lb. one foot. It may be added that a good sketch of Joule's apparatus, and description of his method of using it, is given in the *Phil. Trans.*, 1850, Part I.

Davy's Lamp, Balance, and Battery.—Here may be seen the very first lamps constructed by Davy, while patiently feeling his way toward a light which could be used with safety in our coal mines. Four or five of the Davy safety lamps in various stages of construction are exhibited.

Also Davy's chemical balance, an unwieldy-looking object compared with the delicate instruments of to-day, is shown.

Perhaps the greatest discovery made by Davy was that recorded in the *Phil. Trans.* for 1808, when he succeeded in decomposing the alkalies potash and soda by electricity, producing the respective alkaline metals potassium and sodium. A portion of the very galvanic battery used is shown, together with the laboratory note book, which is opened at the page in which the record may be read in Davy's handwriting. Sodium is now an article of commerce, and fine specimens of it may be seen at stand 804, just opposite, shown by the Magnesium Metal Co., limited. It is chiefly used in the manufacture of aluminum.

Faraday's Note Book.—One of Faraday's greatest discoveries was that of the possibility of liquefying certain gases, up to that time regarded as permanent, by means of strong pressure.

Specimens of liquefied gases are shown in sealed tubes. These are hydrochloric acid, cyanogen, ammonia, arseniureted hydrogen, hydrobromic acid, chlorine, chlorine and sulphuric acid, sulphureted hydrogen, and hydriodic acid.

Faraday's laboratory note book, which is also exhibited, is opened at the place where this discovery is recorded.

Coal tar distillers, gas manufacturers, and aniline dye manufacturers will be greatly interested to see the very first specimen of benzene as it was originally isolated and prepared by Faraday. It was called by him "bicarbide of hydrogen," the old formula of benzene being $C_{12}H_6$.

The other specimen, also contained in a sealed tube, is one of carbon tetrachloride, prepared by him.

Berzelius' Plate.—A plate of earthenware is shown on which characters have been inscribed, burnt in and glazed. The characters are in the handwriting of the great chemist Berzelius.

Passing on to those exhibits illustrating chemical research, it may be noted that some of the discoveries which have had the most important influence on the development of chemical industry were made *accidentally*, during investigations in quite other directions.

Vanadium and Tungsten.—Sir Henry E. Roscoe, M. P., F.R.S. (No. 741).—This exhibit comprises a collection of specimens of pure vanadium and tungsten, with various compounds of these rare metals, illustrating Roscoe's researches. Roscoe found vanadium in deposits near Alderley, and when subsequently John Lightfoot showed the important influence this metal was capable of exerting, even in mere traces, in printing aniline black, Roscoe suggested to Mellor of Patricroft the industrial preparation of vanadium compounds for the use of the printer of aniline black. Mellor procured a quantity of the raw material from Mottram, near Alderley, and manufactured vanadium compounds for a considerable time. The specimens exhibited illustrate a very completely worked out research in inorganic chemistry.

Dr. Edward Schunck, F.R.S. (No. 741A).—The specimens exhibited consist for the most part of natural coloring matters. Some of them, it will be observed, are colorless, or only slightly colored; these are chromogens, *i. e.*, bodies which, when suitably treated, yield coloring matters. As an example of a chromogen we may take orcin, a colorless crystallized substance contained in various species of lichen, which, by the combined action of air and alkalies, yields orcin, the coloring matter to which orchil and litmus owe their dyeing properties. Orcin was discovered by Robiquet, an eminent French chemist. Dr. Schunck, many years ago, discovered lecanorin, a body which, when acted on by alkalies, splits up into orcin and carbonic acid, and is the substance, or one of the substances, originally contained in the lichens which are employed for dyeing purposes.

Since then a great number of similar substances, some well crystallized and all of them interesting, have been obtained from lichens. It is difficult to understand what function these well defined chemical substances perform in the cells of such lowly organized plants as lichens. Whether so far as the plant is concerned they simply represent excrementitious matter is doubtful, but they certainly afford us a very beautiful though somewhat fugitive dye, orchil, and a pigment, litmus, much used by chemists as a reagent for acids and alkalies.

Another instance of a chromogen is seen in rubianic acid, a substance crystallizing in yellow needles, obtained from the root of the madder plant, *Rubia tinctorum*. This root has been employed for ages in the East for dyeing turkey red and other colors, but it was not until about the year 1835 that the substances to which it owes its tinctorial properties were detected.

Alizarin, the most important of these substances, was discovered and described by Robiquet. Specimens of this coloring matter in various states, and also of purpurin, another coloring matter contained in the root, and closely allied to alizarin, will be found in the show case. Alizarin yields a variety of colors on calico, red, pink, black, lilac, etc., according to the mordant used and the treatment employed. Now this substance, alizarin, is not contained as such in the plant, *i. e.*, it is not there in a free state, but exists in combination with glucose, forming a peculiar compound, rubianic acid, which is itself quite incapable of dyeing, and only exhibits tinctorial properties after decomposition with acids or ferments, *i. e.*, after it has split up into alizarin and glucose (grape sugar). It is the natural ferment of the root, which, in the ordinary process of dyeing with madder, causes the decomposition of the glucoside (such is the name given by chemists to this class of substances) into alizarin and glucose.

It should be stated that Rochleder was the first to discover a glucoside yielding alizarin by decomposition with acids. He called it ruberythric acid, but since this differs in some of its properties as well as in composition from rubianic acid the latter name is retained. The characteristic property of rubianic acid, that of yielding a potassium salt crystallizing in plum colored needles (of which a specimen is exhibited), is not mentioned by Rochleder. It was the analysis of this salt which led to the conclusion that alizarin contains 14 atoms of carbon, a fact of importance in connection with the artificial production of alizarin, which, if due attention had been given to it, would have shown that the attempts made to obtain the latter from naphthalene, a substance containing only ten atoms of carbon, could not possibly succeed. The other substances extracted from madder—rubian, rubiadin, purpuroxanthin, etc.—are mere chemical curiosities of no practical importance. The very beautiful substance munjistin, obtained by the late Dr. Stenhouse from munjeet or Indian madder, should, however, not be overlooked. Purpuroxanthin, which is a product obtained by reduction from purpurin, is isomeric with alizarin, but does not dye mordants. Munjistin is purpuroxanthin carbonic acid, and rubiadin is probably methyl-purpuroxanthin.

The artificial production of alizarin from anthracene, a coal tar constituent, is one of the most important discoveries of modern times, from a scientific as well as a practical point of view. The history of this discovery and its practical consequences will doubtless be discussed in connection with other exhibits, and may therefore be passed over here. It may, however, be mentioned that during the process of making artificial alizarin as originally carried out a considerable amount of another substance is formed, which was noticed first by Dr. Schunck, and named anthraflavic acid. This was shown by Dr. Perkin to be isomeric with alizarin, though quite incapable of combining with mordants. By fusion with caustic alkali anthraflavic acid is converted into flavopurpurin, which is isomeric with ordinary purpurin, and is endowed with marked tinctorial properties. It is now prepared on a large scale for the use of dyers.

Chrysammic acid, the salts of which are colored and remarkable for their golden, semi-metallic luster, is also a derivative of anthracene. It was, however, obtained originally by the action of nitric acid on aloes. It belongs to the same class of compounds as picric acid, and, like the latter, may be employed for dyeing purposes.

Indigo, the well known blue dye, is obtained, as most people are aware, from the leaves of various plants. In what state the coloring matter is contained in the indigo plant was formerly unknown, the leaves showing no blue tint when fresh and uninjured, but having the same green color as any other leaves. Dr. Schunck showed that the coloring matter is contained in the plant as a pale yellow glucoside, easily soluble in water, which he called indican. This, like other glucosides, is decomposed by acids, splitting up into indigo and a peculiar kind of sugar, and thus the fact of indigo, which is an extremely insoluble body, being removed from plants by means of cold water was easily explained.

There is a specimen of indican from *Indigofera tinctoria* among the exhibits, but, being a body very easily decomposed, it has already begun to show signs of change, the surface being covered with a blue film of indigo. Its physical properties are not interesting; it never assumes a crystalline form, always appearing as a yellow sirup. All commercial indigoes contain a certain proportion of a red coloring matter. This red coloring matter was first obtained by Dr. Schunck in a state of purity, and called by him indirubin. It is a very interesting body, crystallizing in red needles, subliming unchanged, and yielding solutions of a fine crimson color. It has the same percentage composition as indigo blue, but is a more stable body.

In dyeing it affords crimson in place of blue shades.

* Report on Section III. of the Manchester Royal Jubilee Exhibition.

Dr. Schunck has shown that by treating indican in a particular way before acting on it with acid it may be made to yield indirubin only, and as the latter would probably turn out a valuable dyestuff, on account of its great stability, a means is pointed out whereby the manufacturer would be enabled to produce a true red in place of a blue indigo.

As a curiosity interesting to physiologists, as well as chemists, the specimen of indigo from urine may be pointed out. Dr. Schunck first showed that all urines, whether pathological or not, contained an indigo-producing body in minute quantities. The chemical nature of this body was first ascertained by Baumann, who showed that it was not a glucoside like the indican of plants, but the potassium salt of a peculiar acid, indoxyl sulphonic acid.

The substances from cotton here exhibited are more interesting to the bleacher than to the dyer, since they represent together the matter which is removed from cotton fabrics during the bleaching process. Among them will be found a dark brown coloring matter which is the substance causing the brown tinge seen in raw cotton. All cotton, however white it may appear, contains some of this coloring matter, but the so-called Nankin cotton has more of it than other kinds. During the bleaching process it is partly removed by treatment with alkaline lye, and in part it is destroyed by the action of chloride of lime. The cotton wax may have something to do with the property that the cotton fibers possess of adhering to each other.

Diazo and Azo.—Dr. J. Peter Griess, F.R.S. (No. 741B).—In this exhibit we have specimens illustrative of the discovery of diazo and azo compounds, more especially the azo colors; also specimens of fabrics dyed with these beautiful and brilliant colors are shown. The history of the discovery of the first diazo compound, which was made in the year 1858, is thus related by Dr. Griess, in a letter to the writer: "Dr. Gerland, when working in the laboratory of Prof. Kolbe, in Marburg, investigated the action of nitrous acid on amidobenzoic acid at the request of Kolbe. Thus the oxybenzoic acid was prepared, indicating a chemical change then considered of much importance.

"In like manner I investigated a means of converting picramic acid (amidodinitrophenylic acid) into the oxydinitrophenylic acid, $C_6H_2(NO_2)_2(OH)_2$, but I obtained instead of this latter a compound possessed of such striking and peculiar properties that I at once concluded it must belong to a completely new class of compounds. Analysis soon showed me that this peculiar compound had the composition $C_6H_3(NO)N_2O$.

"Naturally I soon submitted many other amido compounds in like manner to the action of nitrous acid, and obtained thus in almost every case the corresponding diazo compound. But the circumstance to which I was indebted for my success in obtaining the diazo compounds was that of the treatment of the amido compounds with nitrous acid in the cold, whereby the immediate conversion of the diazo compounds into other products was prevented; whereas in the earlier experiments of Hunt and Gerland a higher temperature was always attained, and consequently no diazo compounds could exist. Having obtained these diazo compounds, I then tried their action upon all possible substances, among which, of course, are the numerous class of amido compounds. I found that the diazo compounds combine directly with these, forming frequently brilliantly colored substances which dye directly animal fibers. The first coloring matter thus prepared by me, which I obtained in the years 1861–62, was the benzene-azo-*a* naphthylamine (see *Phil. Trans.*, 1864, Part III., 679). It was first prepared on the large scale, to the best of my recollection, in the years 1865–6, by Caro, who was then chemist in the works of Messrs. Roberts, Dale & Co., of Manchester. I first recommended the oxyazobenzene obtained by me for use as a coloring matter in *Liebig's Ann.*, 137 (1866)."

It will be observed from this, as in the case of Perkin's mauve, that these bodies were never thought of until they appeared, but came unexpectedly and unsought. At the present moment the conditions on which the formation of coal tar colors depend are so well understood that in forecasting a new substance it is not only possible to predict of what color it will be, but also whether it will be a dye soluble or insoluble in water, etc.

The following azo dyes of principal historic interest are exhibited by Dr. Griess:

1. *Benzene-azo-phenol.* Discovered 1861–3. See *Phil. Trans.*, 1864, III., 689.
2. *Benzene-azo-α-naphthylamine.* Discovered 1861–3. *Phil. Trans.*, 1864, III., 679.
3. *Diphenyl-disulpho-azo-α-naphthylamine sulphonic acid.* The first known cotton dye of the Congo red type. Discovered 1882. Eng. Pat. 1,099, January 9, 1884.
4. *Dimethylaniline-azo-p-benzene sulphonic acid* ("Helianthine" or "Orange No. III."). Described *Ber.* 10, 528.
5. *β-Naphthol-azo-p-phenol sulphonic acid.* First known red azo dye. Eng. Pat. 3,698, October 4, 1877.
6. *Anisol-azo-β-naphthol sulphonic acid* ("Anisol red"). Eng. Pat. 4,726, November 20, 1878.

The first diazo compound, viz., *diazodinitrophenol*, was discovered in 1858. (*Liebig's Ann.*, 106, page 123.)

Mauve.—Dr. W. H. Perkin, F.R.S. (No. 741C).—This is an exhibit of very special interest, inasmuch as it marks a completely new era in the history of coloring matters and dyes. Perkin was the discoverer of the first coal tar color, but, singular to say, he did not in the experimental research he was carrying out expect a color, and, in fact, from the scientific standpoint, he did not want a color. He was working in 1856 on aniline with a view to produce quinine, but obtained mauveine or "mauve" instead. Specimens of the original mauve are shown, both solid and in solution. The only small use to which mauve is now put in this country is for coloring postage stamps. It has been completely superseded by the finer methyl violets.

Perkin patented his method for producing the color, which was by oxidizing sulphate of aniline, containing also sulphate of toluidine, with potassium bichromate, forming sulphate of mauveine or "mauve." A specimen of safranine is also shown, produced by the oxidation of the mauveine.

In the year 1869, Graebe and Liebermann having shown that alizarin is an oxidized derivative of anthracene, Perkin devised a method of manufacture which was subsequently known as the English method, and by its use the necessity of first oxidizing anthracene to anthraquinone was avoided. The anthracene was chlorinated, dichloranthracene being formed, that on treatment with fuming sulphuric acid yielded the sulphonic acid of dichloranthracene. But on heating the mixture, hydrochloric acid and sulphurous acid were evolved, and a conversion into a sulphonic acid of anthraquinone took place.

The German method involved the direct oxidation of anthracene to anthraquinone by means of bichromate of potash and sulphuric acid, and the subsequent heating with strong sulphuric acid to insure sulphonation. The sulphonated product is in both methods then fused with considerable excess of caustic soda, when the alkali abstracts the elements of the sulphuric acid and leaves a hydroxy product, which may be alizarin or one of its congeners.

Specimens are shown of a wide series of anthracene, anthraquinone, and alizarin derivatives. Perkin also discovered a valuable means of purifying anthracene, by distilling it from potash. By this method, the Germans say, a 10 per cent. loss is sustained, but Perkin denies that such is the case. The residue is then found to contain a remarkable substance called carbazol, a body containing nitrogen. A specimen is shown of this beautiful body.

But alizarin is only one of a series of colors produced from anthracene, and the great advantage of the synthetical methods of preparing these coloring matters from the one common source, anthracene, is that, according to desire, either one or other color of this series may be obtained, whereas in working the madder root, the dyer must take and use what nature has put into his hands. Perkin also succeeded in preparing artificially for the first time the odoriferous principle contained in the sweet scented Tonka bean—viz., *coumarin.*

Specimens of *cinnamic acid*, first prepared by Perkin, are also shown. Cinnamic acid is remarkable as being the raw material used in the preparation of artificial indigo.

Petroleum. — Prof. C. Schorlemmer, F.R.S., and Messrs. R. S. Dale, B.A., and C. Schorlemmer (741A).—In the show case in which Dr. Schunck's specimens are displayed will be found a small case of bottles and specimen tubes containing preparations neither large in bulk nor striking to the eye. Nevertheless, these specimens illustrate a very important series of chemical investigations. There are, first, a series of samples of the pure constituents of American petroleum, separated and prepared for the first time by Professor Schorlemmer. Schorlemmer conclusively proved that these constituents are not alcohol radicals, as was at first believed, but the hydrides of those radicals. The final result of this research was the grand division of organic substances into the paraffin series and the aromatic series.

It has been stated that American petroleum contains absolutely none of the members of the benzene series, but this statement Schorlemmer shows not to be true, for among his little specimens may be seen some crystallized dinitrobenzene, which he prepared from Pennsylvanian petroleum.

Secondly, specimens of pure aurin and aurin derivatives, substances of considerable interest to the dyer, illustrating the joint researches of Dale and Schorlemmer, are also shown.

GROUP I.—CHEMICAL AND PHYSICAL APPARATUS.

W. H. Bailey & Co., Albion Works, Salford (No. 701).—This firm exhibits apparatus and machinery used chiefly by chemical manufacturers, bleachers, engineers, etc. Especially is the exhibit interesting for the variety of pyrometers shown, some of these, as well as other physical apparatus, being the inventions of Mr. W. H. Bailey. The question of the precise temperature at which a large number of chemical and physical changes occur is one which has only recently received attention. The carrying out of operations on the large scale involving chemical changes is being brought into continually closer approach to scientific and laboratory method, and thus, just as the thermometer is essential in the latter, so the pyrometer must be adopted in the former. This firm exhibits Hargreaves and Robinson's hydrochloric acid pump, stopcocks for hydrochloric acid, and lead-lined valves for acids and sours. A pump for raising an almost equally corrosive liquid, viz., bleaching liquor, is also shown.

Of patent pressure recorders, air compressors, pyrometers for all kinds of special purposes, such as for blast furnaces, japanners' stoves, portable army ovens, biscuit bakers, confectioners, for the Hargreaves and Robinson salt cake plant (a model of which can be seen just opposite Messrs. Bailey's stand), etc., there is a great variety. The large automatic mortar and pestle exhibited is a curious as well as ingenious piece of mechanism.

Messrs. Doulton & Co., Deansgate, Manchester, and Lambeth Pottery, London.—This firm shows at Stand 702 interesting specimens of earthenware acid pipes, pumps, and taps of various sizes. Besides these, a feature is made of retorts, stills, receivers, condensing worms, store jars, chlorine retorts, unglazed chemical pipes for boiling in tar, specimen of hydrochloric acid pipes which have been in actual use, stoneware jars and bottles, with patent screw stoppers to 3 in. diameter; 24 in. diameter stoneware pipes, free from iron, for acid towers; plumbago and other crucibles, and various goods capable of resisting the action of fire.

Messrs. Follows & Bate, Limited, Gorton, Manchester (No. 703), exhibit apparatus used by wholesale drug and fine chemical manufacturers, as well as by viticulturists. A specimen of an edge runner mill, with granite rollers, measuring 18 by 6, and granite bed 2 ft. in diameter; drug mills for grinding such friable materials as gentian, ginger, and copperas; also a powerful tincture press so designed that no part of the material operated upon can come into contact with iron or other metallic substance used in the construction of the press. The size of the hopper of this useful apparatus is nine gallons, and the calculated pressure of the plunger is six tons. A small iron circular tincture press, capacity one gallon, for chemists, a 65 gallon wine press and a grape crusher with rollers 29 in. by 7 in., numerous specimens of granite pestles and mortars, and an assortment of hand power horizontal mixers for light powders, liquids, semi-liquids, and soluble compounds are also exhibited.

William Allen, Union Brass and Iron Works, Great Ancoats Street, Manchester (No. 717).—In this exhibit are shown Allen's improved filter press in its complete form, and fitted up with 24 chambers; also a 3 in. ram pump to be used with it. The press is suitable for the filtration of products in almost all kinds of chemical works. He also exhibits his patent regulus screw down acid jug valve, made of regulus metal, his plugs and seatings, cocks and injectors.

Messrs. Shaw & Connolly, electrical engineers, Manchester (No. 706), display Miles Settle's patent electric miners' lamps, as used at Darcy Lever Colliery, Bolton, and Madeley Colliery, Staffordshire, patent water cartridge, exploded by electricity, and all the necessary apparatus; mine signals, some fine specimens of the deep seam cannel, a collection of cables and derivations for mine lighting, and a remarkable fossil tree (a Lepidodendron) from the Bolton coal field.

Messrs. Shaw & Connolly, Varley Street, Manchester (No. 707), also exhibit insulated wires, as well as cables for submarine, torpedo, electric light, telephone, and telegraphic purposes. Five special varieties of insulated wires are shown, suited for different circumstances and purposes; also flexible cords, of which a large number of specimens are to be seen. There are wires differently insulated to suit all the following exigencies: Great dryness, for internal work where walls are rather damp; decided dampness and exposed position (this variety the best to use in cotton mills, weaving sheds, and the like), when laid under water or subject to temporary or permanent heat, also exposed to acid or other chemical fumes or to sea water. Besides these there is a variety like the last, but with additional coverings to protect and preserve from mechanical injury. This is the variety used by Holroyd Smith, and alone found available for the collectors of his electric tramways. A portion of such a collection is shown. Owing to the increase in size of dynamos, it was found necessary to provide a copper conductor of very large section for the connections, which at the same time was to be flexible enough to handle with the greatest ease. A piece of the largest cable ever made for this purpose is exhibited. It is used on an Edison-Hopkinson dynamo made for Germany, and is required to carry the current for 1,400 lights. It is composed of 1,818 copper wires, stranded in the best manner possible, and this has been done so successfully that, although the copper cable is 1½ in. in diameter, it can be easily tied into knots with the hand.

Specimens of cables used for telephone, electric light, torpedo, mine signaling, blasting, domestic, and other classes of work are exhibited. Cables for transmission of power are also coming into use, and as an example the cable is pointed to which is used by Messrs. Mather & Platt, and specially constructed by Messrs. Shaw & Connolly, to transmit the power to work their bleaching plant from the dynamo house.

J. W. Lovibond, St. Ann's Street, Salisbury (No. 704), exhibits an apparatus for measuring colors called a tintometer. We believe this apparatus has a useful future before it. It is a new instrument, by means of which the depth of color in liquids and solids can be accurately measured in degrees and placed in their position in a permanent color scale, and mainly consists of a standard scale made of colored glasses numbered according to their depth of color, and an instrument for holding the glasses and the object to be measured. It is likely to be of service wherever color is an index for manufacturers or where a permanent record of colors is desirable.

Edward Ward, F.R.M.S., 249 Oxford Street, Manchester, exhibits microscopes and appliances for microscopic investigation, mounted slides and unmounted specimens, and photographic apparatus and lantern slides of scientific apparatus. An interesting feature of this exhibit is a special row of microscopes ready mounted and furnished with objects to be viewed at any time by those interested in entomology and natural history.

Joseph Davis & Co., Fitzroy Works, Kennington Park Road, London, S.E. (No. 705), exhibit Royal Polytechnic and other barometers, optical and scientific instruments of various kinds.

The Committee of Section III. and Watson Smith (No. 709).—Model of the Hargreaves salt cake plant, as used for the direct conversion at a high temperature (about 500° C.) of common salt into sulphate of soda, by means of sulphurous acid, steam, and air.

Harden Star and Sinclair Fire Appliance Company, Limited, Victoria Street, Manchester (No. 710).—All kinds of fire appliances. The Lucigen light apparatus, used during the dark evenings of last winter to enable the exhibition workpeople to continue the erection of the buildings by night, is exhibited. It is a simple but very effective means of utilizing the "creosote oil" of the tar distilleries, recently become so cheap as to be almost a waste product.

Joseph Casartelli, Market Street, Manchester (No. 712).—All kinds of surveying, mining, and engineering instruments, thermometers for industrial and other purposes, as well as hydrometers, etc., in which the special features of accuracy and lightness combined with strength are desired.

Franz Mueller, formerly Dr. H. Geissler, of Bonn, Germany (No. 713).—This exhibit contains, among other things, a complete Geissler's mercury air pump, with all the accessories, also sets of Crookes', Geissler's, and Puluj's tubes and apparatus. Attention must be especially called to the new form of the Crookes apparatus containing rhombs of phosphorescent minerals, which on being electrified become apparently incandescent, and radiate the most beautiful colored light. There is to be seen also a new electric radiometer, which carries phosphorescent wings. The fine show of delicate standard or normal thermometers will be interesting to the scientific chemist and chemical physicist. All the finer thermometers are constructed of Jena normal glass. The series of clinical thermometers contains instruments each of which is furnished with a kind of registering vernier with zero point graduation. A baro-thermometer is exhibited, the thermometer of which is divided into $\frac{1}{10}$ths of a degree. This extremely sensitive instrument marks differences of height of only two meters (6½ to 7 feet). These are perhaps among the most striking objects in the valuable collection shown by the Geissler Institute. A beautiful illuminated display was made at this stand during the visit of the British Association.

F. C. Rein & Son, Strand, London (No. 715), show acoustic apparatus and instruments for deafness. John Heywood, Ridgefield, Manchester (No. 722), shows a completely fitted up chemical laboratory table, with all the newest appliances; while Messrs. Mottershead

& Co. and Messrs. James Woolley, Sons & Co. vie with each other in the beauty and interest of their exhibits of chemical and physical apparatus (Nos. 720 and 722 A). The Rex Bituminous Coal Company, Hulme Hall Road, Manchester (No. 719), exhibit specimens showing the advances in the manufacture of patent fuel, a branch carried on to a wonderful degree of perfection in France and Germany, where coal is scarcer and dearer than in this country.

Henry Simon, Mount Street, Manchester (No. 718) exhibits models and drawings of apparatus by the use of which the smoke and fumes from coke ovens of the beehive or open variety are completely abated, and in place of that smoke, tar and ammonia are obtained. The ammonia water is worked up into sulphate of ammonia and liquor ammoniæ, while the tar is distilled and products obtained from which coal tar colors are prepared. The colors thus made are exhibited, as well as fabrics dyed with them. There is shown a model of a Simon-Carves recuperative coke oven, with adjustments for the recovery of by-products, and also a drawing giving a sectional elevation of the coke oven, with the apparatus for the automatic discharge of the finished coke.

There is also shown a model of a continuous ammonia still (Simon's patent), so arranged that either ammonia solution ("liquor ammoniæ") or sulphate of ammonia can be made at will, and that, while the crude ammonia water is being fed in at one end, the liquors exhausted of ammonia down to some two-hundredths of a per cent. are running off at the other by a suitable overflow pipe. A drawing is shown of a sulphate of ammonia works arranged on Simon's principle at the Stafford corporation gas works, and another of a liquor ammoniæ works as erected on the similar principle at the Michigan Ammonia Works, Michigan. Processes have, as is well known, been devised for extracting the benzene hydrocarbons from coal gas, so that they might be eventually worked up into aniline colors. We observe that a series of products similarly recovered from the gas of the Simon-Carves coke ovens is exhibited. The gas was treated by the large Swiss color manufacturing firm, Messrs. Durand & Huguenin, and an interesting series of aniline dyes thus obtained is shown, together with silks dyed with these colors.

The East Lancashire Chemical Company, Fairfield, near Manchester (No. 721), exhibits plant for bleaching cotton and linen yarn and cloth by the "blanchine" process—*i. e.*, using blanchine instead of soda ash, but no lime, and only very little bleaching powder and acid; a starch substitute for stiffening, and goods thus stiffened; also a patented substitute for bone size used for stiffening fustian goods. Of bone size it is alleged that it smells badly and communicates its odor to the goods. This substitute is guaranteed to do the work without communicating any odor. There is also a powder soap specially adapted for the "white grounds" of alizarin prints. It is commended by the firm on the score of economy and effectiveness. A variety of other drugs and chemicals used by calico printers and dyers, with models of apparatus, is exhibited at this stand.

George E. Davis, 301 Great Clowes Street (Southwest Gallery, No. 937), exhibits specimens of raw materials and products used and produced in apparatus and plant, the drawings of which are shown. The following is a list of the principal items in this collection:

1. Drawings of the Poirion evaporator, with samples of esparto liquor and recovered ash.
2. Drawings of plant erected for making liquor ammonia direct from gas water.
3. The drawing of a pyrites smalls burner is shown. Seville smalls may be burnt in it with as much as 8 per cent. of Cu, so that half of this copper becomes soluble in acidulated water alone, and when the residue is calcined with salt, the spent ore or "blue billy" contains less than 0·15 per cent. Cu.
4. Specimens of benzene, toluene, xylene, solvent naphtha, naphthalene, anthracene, and sulphate of ammonia, made by Davis' patented carbonizing process from the celebrated Rockingham coal.
5. Drawings of kilns for burning the spent oxide of gas works. In these kilns every provision is made for the thorough combustion of the organic matter before coming in contact with the nitrous gases. If not burnt, the carbonic oxide or organic substances would reduce those nitrous gases and cause an undue consumption of niter.
6. Drawing of a hydrochloric acid condensing tower of the usual pattern, except with regard to the method of taking off the acid, which is novel.
7. Glover tower on Davis' pattern, having a low form and only seven feet of packing, which, in practice, it is claimed, has been found to answer very well. These towers are packed with a special blue brick, and the area of the tower is apportioned to the work to be done in it, the height always remaining the same.
8. A copper calciner, fitted with a Mond's smokeless fireplace.
9. Samples of products obtained on an industrial scale from the condensed gases from beehive coke ovens.
10. Samples showing the Davis and Aitken method of treating sewage and refuse water from various manufactories. Specimens are shown of the Salford sewage treated by this process, and the refuse water of a dyeworks before and after treatment.

GROUP II.—HYGIENE.

Messrs. Mottershead & Co. (No. 723) exhibit Benger's natural digestive ferments, peptonized foods, fluids and powders. The writer showed that beef tea prepared by adding a very little of the "liquor" preparation to mince beef and water contains just three times as much nutritive matter as ordinary beef tea prepared from just the same proportions and quantities of mince beef and water without the addition of the "Pancreaticus Benger."

A similar experiment, followed by the same success, was observed on adding some of the fluid to thick gruel or arrowroot, these compositions soon becoming liquefied through the partial conversion of starchy matter into glucose. These experiments were described by Sir William Roberts in the course of a lecture before the College of Physicians, London.

Messrs. James Woolley, Sons & Co., Market Street, Manchester (No. 725), exhibit antiseptic preparations, and all kinds of elegant and useful toilet articles, both perfumed and antiseptic.

Burroughs, Wellcome & Co., Snow Hill Buildings, London, E. C. (No. 724).—Professor Oscar Leibreich, of Berlin, first successfully investigated the chemical composition of the fat or grease of the wool of sheep, and found it to contain cholesterin. The commercial article is termed "lanolin," and it has a marvelous power of forming an emulsion on shaking up with water and of penetrating the skin when applied to it. This firm shows specimens of lanolin, lanolin pomades, soaps, cold creams, and ointments of various kinds.

M'Dougall Brothers, Port Street, Manchester (No. 726), exhibit a large variety of carbolic and sulphurous disinfectants in powders, liquids, and soaps; also Morris, Little & Son, of Doncaster (No. 737), show similar preparations, dog soaps, containing phenols, etc.

Winser & Co., of Harter Street, Manchester (No. 728), lay stress on their new antiseptic and disinfectant, which they term "salufer," chiefly composed of alkaline fluosilicates. It is stated that 1½ parts of this compound have greater power of preventing the growth of mildew on flour paste or cloth sized with flour or starch than 14 parts of the best chloride of zinc in the commercial form.

F. J. Harrison & Co., Limited, of Leicester (No. 729), and Swan & Leach, of Albert Square, Manchester (No. 730), show many varieties of sanitary and disinfecting soaps, soap powders, and preparations for household, toilet, and other uses.

(To be continued.)

CHEMICAL ASSAY OF TISSUES.

THE solubility of animal fibers in strong alkaline liquids and the insolubility of vegetable matter under the same circumstances is a summary way of detecting wool in presence of vegetable matter. Mineral acids and acid salts, on the contrary, have no action on animal fibers, while they gradually carbonize vegetable fibers. [Both these latter propositions must be accepted with reservations.] Animal fibers are colored yellow by nitric acid, and turn red if heated in Million's reagent (mercuric and mercurous nitrate). These phenomena are not produced with vegetable fibers. Vegetable fiber (cellulose), as well as silk, dissolves readily in ammoniacal copper oxide, and the former can be reprecipitated by a number of salts, by sugar, and by gum. Silk can be reprecipitated only by the aid of weak acids. According to Peligot, a solution of copper oxide in ammonia, well fitted for reacting on tissues, may be obtained by dissolving in a little ammonia with access of air, copper filings, or electrolytic powder of copper. Nitric acid, without apparently attacking vegetable fibers, dissolves silk in time and colors wool yellow.

According to Schlossberger, the ammoniacal solution of nickel oxide dissolves silk very readily without attacking cotton. As wool always contains sulphur, it may be recognized as follows: Lead hydroxide, dissolved in caustic alkali, blackens when brought in contact with wool. This test is worthless if sulphured silk is simultaneously present. Liebermann prepares a saturated aqueous of solution of magenta and adds caustic alkali by drops until the color has disappeared. The liquid is then filtered, and the tissue in question is immersed in the filtrate and washed in much water. The wool in the tissue then appears colored red, while cotton remains colorless. Silk behaves like wool. Persoz finds that silk dissolves readily in a hot solution of zinc chloride at 60° B. On this fact he founds a method of determining the silk quantitatively, which has been subsequently developed. Three samples of the cloth (2 lb. each) are boiled in 200 c. c. of hydrochloric acid at 3 per cent., in order to remove the dressing, and they are then carefully washed and pressed. In case of colored goods cotton very quickly loses its color, wool is stripped more slowly, and silk more slowly still. Two of the swatches thus prepared are immersed in a boiling solution of zinc chloride containing 850 parts of water, 1,000 znic chloride, and 40 parts zinc oxide.

The difference of weight before and after the treatment shows the quantity of silk found in the tissue. On heating the third swatch in 60 to 80 c. c. of caustic soda (at sp. gr. 1·02) for fifteen minutes at 100°, washing and drying, the quantity of wool is shown by the difference of weight before and after treatment. In his work on the structure and assay of silks, Hoennel gives another method for the qualitative and quantitative determination of the different fibers. Mulberry silk behaves quite differently from wild silks with a solution of chromic acid. If a sample of the former is plunged into a solution of chromic acid saturated in the cold and then diluted with an equal volume of water and boiled for one minute, the silk dissolves completely. Wild silks remain apparently unaltered after boiling for two to three minutes. Wool behaves in this solution like mulberry silk. Different kinds of silk behave differently with a boiling and moderately strong solution of caustic potassa, in which true silk is attacked more rapidly than adulterated silks. [It does not appear whether this expression refers to weighted silks, or by an abuse of language to wild silks.] To separate wool from mulberry silk, the best method is to treat the swatch with boiling hydrochloric acid, in which silk dissolves rapidly and wool swells up, but without dissolving. This method may also serve for the quantitative determination of the fibers forming the tissues. To distinguish wool from "adulterated" silks the above mentioned solution of chromic acid may be used. On heating in this solution wool dissolves very rapidly, while the adulterated silks resist. In this manner may be distinguished a mixture of cotton, wool, mulberry silk, and Jamaimai silk as follows: On boiling this mixture in hydrochloric acid the silk dissolves in half a minute; on boiling for two minutes in strong hydrochloric acid the Jamaimai silk dissolves. In the residue the wool is dissolved by caustic alkali and the cotton remains unchanged. Cellulose, if treated with acids, is partly transformed into sugar. By taking advantage of this fact, and of the property of sugars to yield beautiful colorations with sulphuric acid and naphthol or thymol, Molisch has devised a new method for distinguishing vegetable and animal fibers. To eliminate every error, the swatch should be repeatedly boiled with water to remove any gum, sugar, etc., present in the dressing. In case of wool care must be taken that it does not contain lice or burrs. Molisch then places in a test tube 0·01 grm. (about) of fibers well boiled and washed in much water; he adds 1 c. c. of water and several drops of an alcoholic solution of naphthol at 15 to 20 per cent., and the liquid is then mixed with an equal volume of concentrated sulphuric acid. If the swatch contains vegetable fibers they dissolve rapidly, and the liquid, on stirring takes a deep violet color. If the fibers are of animal origin, the liquid takes a more or less intense yellow, even up to a reddish brown. If we use thymol instead of naphthol we obtain, under the same conditions, a color midway between vermilion and carmine. Silk behaves like the animal fibers. Dyes do not interfere with this reaction. According to A. Lidoff, raw silk dissolves rapidly in melted oxalic acid, cellulose slowly, and wool not at all.—*Technik; Chem. News.*

NEW METHOD OF PRESERVING BUTTER.

THE French *Moniteur Industriel* states that M. Pierre Grosfils, of Vervier, has communicated to the "Societe d'Encouragement de Vervier" a note on his process for preserving butter. After having enumerated the causes which led last year to the lowering of the prices of dairy produce, and especially of butter, he dwells upon the unfortunate results of the over-production of this article, and on its falsification by means of oleomargarine. He has discovered a way of preserving butter, without alteration, for a long period, so that it can be imported into countries the climate of which does not permit it to be made there. The process has been subjected to practical experiments for more than six months. M. Grosfils describes the various phases of his research as follows: He first mingled 1 grm. of salicylic acid with one kilo. of butter, but after some weeks the product had altered. He thought that the cessation of the antiseptic action of acid was due to its crystallization in the non-liquid substances which were mingled with it. After numerous experiments, he found that lactic acid prevents this crystallization. This acid is, in fact, a good solvent for salicylic acid. It has the advantage of being hygroscopic, of possessing antiseptic power, and, finally, of being uninjurious in food.

The first result of the discovery of M. Grosfils was to be able to diminish the amount of salicylic acid used to preserve the butter. Instead of mixing 1 grm. of acid per kilo., he put the butter in a liquid containing 0·05 per cent. of salicylic acid and 3 per cent. of lactic acid. He successively divided the salicylic acid into still smaller doses, until at last he had the proportion of 1 grm. of acid to 5,000 parts of water. The final composition consisted then of 98 parts water, two parts lactic acid, and 0·0002 of salicylic acid. This composition allows of the indefinite preservation of butter of good quality, even at a high temperature and in hot countries. If the butter has already undergone some alteration, a stronger dose must be used.

But the author points to the following fact: The lactic acid contained in the antiseptic liquid in doses stronger than 2 per cent. gives the product a taste which, without being offensive, is a little too sour to leave the article salable. In such case the butter should be washed with water, or better still with scalded milk, to which a little carbonate of soda has been added to prevent any coagulation of the casein. This washing will not only remove the lactic acid and its taste, but also the salicylic acid in solution, to such a degree that what remains will be imperceptible.

The process is stated to be most economical, as the antiseptic liquid will serve indefinitely, being unalterable. Care must be taken each time to use the same quantity of butter.

The preparation of a kilo. of butter by means of this process, it is stated, will not cost more than one or two centimes.

ST. MARK'S, VENICE.*

THE patriarchal or ducal church of St. Mark, in Venice, is a little world in its variety. Pedants, who have a critical rule which they apply to everything, can find as many rules violated in it as in the plays of Shakespeare. The orthodox Forsyth was disturbed by its "strange, unchristian look." Although most of the materials came from Greece, their combination was, in his eyes, "neither Greek nor Gothic, nor basilical, nor Saracenic, but a fortuitous jumble of all." His thrifty spirit was annoyed at the crowding of so many columns into a limited space, and, strong in his recollection of the whitewashed temples of his native land, he could not fail to condemn the lavish use of porphyry, marbles, and mosaics—such a variety of colors, he said, "would impair the effect of the purest architecture."

There are many who still judge of the building in a similar spirit; but fortunately, the acceptance of their standard is not compulsory. St. Mark's can be admired, although it has not the severity or simplicity of a Greek temple, and denotes little constructive skill in its masons. It is unique among the world's buildings—one where form gives precedence to color, and, as such, it must be judged by special rules.

It would be no less injudicious to apply a rigid code of morality to the history of the church. We must not inquire too curiously about how the materials were obtained. Time, which has softened down many glaring colors both within and without the building, has thrown a halo over the deeds of Venetian pirates and filibusters. The world no longer troubles itself with thinking of the crime that was committed when the relics for which this church was to be the shrine were stolen. The Venetians euphoniously describe the deed as "la traslazione del corpo di San Marco Vangelista da Alessandria;" and we feel a debt of gratitude is owing to the strong hands who carried off antique altars, early Christian enamels, porphyry statues and columns, bronze horses, Greek manuscripts, and reliquaries formed of precious stones. For anything that was valuable a place was always ready in the strange temple. It is no wonder the fame of the treasury was worldwide.

St. Mark's is one of the best storehouses of remains of antiquity. Recognizing its value in that way, a work was commenced about forty years ago, under the patronage of the Austrian government, and was intended to illustrate the building and its contents. It was not completed. An enthusiastic Venetian, Signor Ferdinand Onganía, resolved to make another effort of the same kind, and after eight years' persevering labor, he has completed the work. The annals of publishing cannot show a more courageous undertaking by an in-

* "A Glance at the Historical Documents relating to the Church of St. Mark in Venice." By William Scott. Venice: Ferdinand Onganía.—*The Architect.*

dividual. There are five portfolios of engravings, chromo-lithographs, and photographs, besides descriptions written entirely by specialists, a series of reproductions of documents relating to the history of the church, a copy of the long and curious engraving of the *procession of the doge*, and a special volume on the treasury. The production of a work of the kind must have involved a very large outlay, and the price announced, which is about 90*l.* for a complete set, will not be considered excessive. But, in order to enable the work to be more easily acquired, Signor Onganía announces his willingness to accept payment by installments which can be spread over several years. It is to be hoped that the public libraries in London and the provinces will be enriched by so worthy a memorial of a building in which are collected the works of artists of eight centuries, besides fragments of antique art.

An abstract of some of the documents relating to the history of the building has been prepared by Mr. William Scott, and, besides serving to point out how far evidence is attainable respecting many of the disputed points in the history, will also suggest something of Venetian ways during several centuries. The first point is whether the existing building is the original St. Mark's, and at one time much ink was spent by antiquaries in an endeavor to settle the difficulty. The modern belief is that the present building is not the church which the Doge Giustiniano Partecipazio and his successors erected in the early part of the ninth century for the reception of the relics of the Evangelist. It appears that about the middle of the following century the people arose against the Doge Pietro Caudiano IV., and having set fire to the Ducal Palace, the church of St. Mark was destroyed at the same time. His successor, Pietro Orsolo, commenced a new building, and it was he who ordered the Pala d'Oro at Constantinople. According to another account the altar piece was brought to Venice in 1105; but possibly that may have been after one of the alterations. The brick walls of the church were, it is believed, completed about 1070, and then began the search for marbles and columns to adorn it. Successive doges accepted the adornment and enrichment of the work as an obligation. It must be remembered that the church was not recognized as a cathedral until 1817; up to that time it was only the "chiesa ducale." The rights which were exercised over it by the occupants of the neighboring palace are suggested, when we read of a doge's wife ordering a passage and a door to be constructed for her use, and which were to be built up when she ceased to require the convenience. The shields and insignia of the doges were hung in the church until 1729. It is remarkable, however, that very few doges were buried in St. Mark's.

The four bronze horses which figure so conspicuously on the west front were among the spoils which the aged Doge Enrico Dandolo carried off from the hippodrome of Constantinople in 1208. If the traditions be correct, they have endured many vicissitudes. They are supposed to have stood originally in Alexandria (one authority says they came from Chios); they were brought to Rome by Augustus, and there they were transferred from arch to arch by different emperors. Constantine sent them to his capital on the Bosphorus, from whence they were shipped as spoils of victory to Venice. In modern times Bonaparte seized on them, and, until 1815, they were to be seen in Paris. According to the analysis of a French chemist, they are made of copper. Another treasure that came from Constantinople is the crucifix of wood, for which an altar was erected on the north side of the nave. On the top of the shrine is an agate, which is supposed to be the largest in the world.

The control of St. Mark's was vested in *procuratori*, who appear to have been sometimes in a difficulty about finding money for the payment of the numerous workmen. On one occasion it was ordered that land should be sold to raise funds. It was as "proto," or chief of the artists, that Sansovino was employed under the *procuratori*, and the story is known of his having to pay a fine of 1,000 ducats toward the cost of rebuilding a library which had fallen while in course of construction. After his death an effort was made by his son to obtain payment for a statue which Sansovino had sculptured. The *procuratori* denied their liability, but meanwhile held possession of the figure, on the ground that it was made out of a marble block belonging to them and used without their authority.

There was the usual tossing of the case from court to court, but finally Francesco Sansovino was so far successful as to be allowed to remove his father's work.

One memorable case which came before the *procuratori* was made known by Signor Quadri, and has formed the basis of George Sand's charming novelette, the "Maitres Mosaistes." About 1537 the authorities considered that the mosaicists were working too slowly for their salaries, and it was agreed that the Brothers Zuccati should every year execute 20 square feet of figure work, or 25 feet of plain mosaic, according to Sansovino's designs. Three years afterward the Brothers Zuccati offered to do 80 square feet if their pay was increased to 100 ducats. Rival artists were at work in the building, and as in Venice a premium was set on underhand reports, the *procuratori* were not long in hearing of the imperfections of the Zuccati, who were admittedly the most artistic of the mosaicists. It was found on examination that the tesseræ were loose, owing to the carrying out of the work in winter, while the proper time was from March to September, the winter months being used only for the preparation of materials. The Zuccati were supposed to spend the summer in amusing themselves. It was therefore announced by the *procuratori* that no extra work was henceforth to be paid for. In 1560 an allegation was made against the Zuccati that, instead of using tesseræ, they substituted pieces of wood or pasteboard in some parts of their figures, and it was followed, in 1563 by an indictment charging them with the crime of scamping the work for which they were highly paid. The investigation becomes remarkable owing to the position of the artists who appeared as witnesses. For the prosecution it was stated that part of the work, being merely a painted surface, disappeared when washed with sand and water. Titian, Tintoret, and Paul Veronese came forward for the defense. Titian was forced to admit that he could not be considered an impartial witness, as the Zuccati and himself were old friends, and one of the brothers was godfather to his Titian's) daughter. But he had to admit the painting, although he tried to minimize the effect by saying that there were tesseræ underneath. Tintoret and Veronese were also obliged to testify to the use of paint. The Zuccati adopted a line of defense that was known before their time in courts and is never likely to become obsolete. They maintained that the painting was the work of rival mosaicists, who were inspired by ill will and the desire of injuring the two brothers. The defense was not convincing to the judges, and one of the Zuccati was ordered to remove the defective parts and to substitute proper mosaic. There must also have been costs incurred, for there is an entry of a debt of 500 ducats which was to be paid within six years.

In George Sand's version of the case, which professed to be based on documentary evidence, the Zuccati are described as the victims of a conspiracy among the Bianchini, who were mosaicists of the mechanical class. Their crime consisted in trying an experiment with tesseræ of wood in figures for which there was no commission, and although they were ordered to replace the parts with stone or enamel, it appears the wooden fragments still remain. They are not perceptible when seen from the floor of the church.

The master mosaicists, like the Zuccati, were paid a fair price, but the ordinary workmen were less fortunate. There is an entry under the year 1576 of a grant of four ducats to one Berto, in order that he might be provided with clothes--his wages were only about a penny a day. On the recommendation of Sansovino he was afterward appointed a master. From time to time toward the close of the sixteenth century, the procurators seem to have received many applications from the masters for an increase of pay.

There was apparently a rise in prices, and the contractor for tesseræ, who was paid 16 ducats per hundred for gold and eight ducats for colored cubes, begged the council to increase the prices to 20 and 16 ducats. The procurators agreed to pay 19 ducats for the gold, and 14 ducats for the colored tesseræ. The masters sometimes grew old in the service of the church. In an appeal for help from Domenico Cadenazzo, it is stated that he was fifty-three years employed on the mosaics, and his ancestors were similarly engaged for five centuries.

The masters did not hesitate sometimes about destroying ancient work in the course of their restoration; but the precaution was taken of ordering a copy of the work by a painter before its removal. The procurators grew alarmed, probably under the influence of some opponents of restoration, and an order was issued prohibiting the destruction of all old work unless there was a resolution voted by them. It was also decided to employ the best artists for the cartoons; but men of that class who were ready to accept commissions on the terms offered—three ducats per figure—were not always forthcoming. Great artists like Tintoret and Titian could not consider the price as an adequate reward for their cartoons. The former was sometimes rather dilatory in completing what he had undertaken.

Theophile Gautier was as much moved with the thought of the hosts of forgotten artists who must have succeeded each other in the cathedral as with the sight of the riches, which in his eyes made St. Mark's "a cavern of gold incrusted with precious stones, that was at once splendid and somber, sparkling and mysterious." But there are many artists whose names will be always associated with the building, and the great work of Signor Onganía will help to extend their reputation in lands which were unknown when they were designing, painting, carving, and laying mosaics in St. Mark's. Italy has of late seemed to be lethargic in enterprise, and the renown of its famous artists is left to the conservation of foreigners, or in other words, to Germans and Englishmen. The venture of Signor Onganía is a sign of a better state of things, and we hope he may have many imitators.

THE DISEASES OF DYNAMOS.*

By Prof. SILVANUS P. THOMPSON, D.Sc.

CONSIDERING the widespread use of the dynamo-electric machine and the mass of literature concerning it that has sprung up, it seems remarkable that no one should as yet have written upon the topic of the maladies to which such machines are liable, their treatment, cure, and prevention.

Not once nor twice has it occurred in the writer's professional experience to be called into consultation over some hitch that has arisen in the maintenance of an electric light installation where the experience of the engineer and the knowledge of the electrician in charge had failed to discover the cause of the breakdown or suggest an appropriate line of action. Under such circumstances one cannot help comparing one's self to a physician called into consultation over a patient. And as a knowledge of the diseases of dynamos and their treatment forms a necessary part of the complete training of the electric engineer, an attempt by a specialist to elucidate the subject and systematize it may appropriately be brought before such a society as this, comprising as it does many electrical engineers.

Moreover, as some of the members of this society have had large and diversified experience in the construction, erection, use, maintenance, and repair of dynamos, the writer hails this opportunity of inviting an interchange of expression from all members present respecting the causes that lead to the breakdown of dynamos and their prevention.

The diseases of dynamos, like those of human beings, may be classified under several heads, whether constitutional or acquired, whether curable or incurable, whether surgical or medical in the treatment required.

The constitutional diseases may arise either from defective design or imperfect construction. A rickety constitution in a dynamo may result either from inherent badness in the forms of those parts which should give strength to the structure, in the employment of bad or faulty materials, or in bad workmanship. Diseases acquired as the result of overwork and of neglect, though classified as acquired rather than constitutional, are more likely to be developed where there is a constitutional weakness. The physician who is called in must have the eye to detect the constitutional taint as well as the more obvious present causes of mischief. When called into consultation upon a human subject, the physician's first inquiry is as to the symptoms that present themselves. Perhaps a clinical examination is necessary to learn the whole of the symptoms in the case. The diagnosis of the case being completed, a course of treatment suggests itself, which course may be of several kinds. A surgical operation may be necessary, or perhaps bandages and poultices may accomplish all that is required. It may be proper to administer drugs; or in milder cases a change of climate or diet is all that is prescribed. Simple rest accomplishes wonderful cures; but in neglected cases long and careful nursing may be the only hope.

It may safely be said that at least four-fifths of the breakdowns that occur with dynamos—whether partial or total—arise from causes that are more strictly within the province of the engineer than in that of the electrician. On the other hand, many of the mechanical faults that develop themselves in the machine might have been avoided had the engineer possessed a better knowledge of the electric and magnetic conditions that obtain in the running of the machine. It is not often nowadays that armatures fly to pieces. That disaster has seldom occurred since good engineers took in hand the construction of dynamos, though it was, relatively to the number of machines used, a not unfrequent occurrence in the days when armatures were mostly designed by electricians who had little or no knowledge of mechanical engineering. On the other hand, any engineer will make a poor builder of armatures who does not understand the nature of the reactions that occur in the magnetic field—how a conductor carrying a current is subjected in the magnetic field to a mechanical force exerted upon it without any visible means of transmission. If he does not understand this, he will not grasp the necessity of so designing and constructing the armature and its spindle that the power applied to the spindle shall be conveyed directly to drive the peripheral conductors. He cannot realize that it is the copper wire, and not the iron cores, that primarily require to have the power applied to them. He may know that insulation is necessary, and that lamination of iron cores is necessary; but he may, for want of full electrical knowledge, apply both the insulation and the lamination in an entirely erroneous manner, and produce a dynamo that will break down directly it is put to any severe test.

Among the complaints to which armatures are subject are the burning out of coils, the burning of the binding wire, and the breaking off of the conductors near the ends where they go to join the respective parts of the collector. The burning out of coils is sometimes due to short-circuiting at the collector between two adjacent sections; but often it arises from short-circuiting in the armature itself. In armatures so constructed that the windings of one section lie partly over the top of those of another section, this evil is more likely to occur than in those that are not so constructed. Short circuit between an imperfectly insulated wire and the iron core beneath it is a frequent source of trouble, and this again arises either from bad mechanical work allowing the iron laminæ to become loose or from the use of unreliable insulating materials. Sometimes armatures are destroyed by charring of the insulation, not in consequence of the overheating of any of the wires, but from the overheating of the iron cores. In such cases either the iron is not properly laminated or else the insulating material between the iron laminæ has failed to insulate. The burning of binding wire clearly arises from want of compliance with the necessary and sufficient electrical conditions. The fracture of the armature conductors near the ends where they turn over to the collector—a most annoying fault when it occurs—appears to be partly mechanical and partly electrical. These conductors are at this point not supported laterally. Any engineer would imagine that they were strong enough to stand any longitudinal or centrifugal force to which they might be subjected. Yet they have to withstand severe lateral forces, arising from the fact that they carry strong currents and are situated in a fairly powerful part of the magnetic field, which here extends beyond the edge of the polar surfaces. Hence they are each racked by a lateral force that comes upon them twice in every revolution; and which, moreover, must strain them severely whenever the current is suddenly cut off or turned on.

The collector or commutator and its brushes are a fruitful cause of trouble. Brush-holders are rarely as substantial as they should be. The conditions of good mechanical work and good electric work are here somewhat antagonistic; but the mechanical work must be good, otherwise the best observed electrical arrangements will fail. The brushes must not slip or jump with the vibrations of the machinery. If they press too heavily, the surface of the collector will be torn into ruts; if too lightly, the edges of the separate sections of the collector will be bitten and rounded by sparks. The curious disease known as the occurrence of "flats" in the collector has been a source of puzzle and annoyance to many. In many cases the occurrence of a "flat" may be definitely traced to a more or less developed fault in some one section of the armature coil. A broken armature coil, the ends of which still touch against one another within their insulating sheath, may go unsuspected; but it may have the effect—by its increased resistance—in causing an increase of spark at the brush just as it passes through the position of commutation. Hence the corresponding bar of the collector will at every half revolution be bitten into by a spark a little more than any other bar is bitten into, and so become flattened as compared with the proper peripheral curvature of its fellows. "Flats" do not, however, always arise from this cause. It has been observed that a "flat" may break out on one bar of the collector; and on turning down the surface of the collector so as to remove it, a "flat" breaks out on another bar of the collector. A "flat" may arise from a flaw in the metal of the bar, which, passing under the brush, gives rise to a spark that bites away the metal a little further to right and left, and so spreads along the bar until the whole surface of it is more or less bitten away. A little more pressure on the brush and a better mechanical holding of the brush are remedies not to be despised. The collector is the one part of the machine most likely to give trouble. It is rarely made large enough. Years of experience have not yet given any decisive answer to the question, What materials should it be made of? While English makers are almost agreed upon using either hard drawn copper or else some kind of hard

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bronze with mica insulation between the bars, Messrs. Siemens and Halske have this year abandoned these for iron bars with air gaps between. Before mica was in general use asbestos was not unfrequently employed, and with curious results. At one time the writer was working with a small Siemens shunt dynamo, giving an open circuit about 80 volts. One day it gave only a little over 70, though the speed was normal. The next day it was under 70, the next it refused to excite itself. The circuits were tested out, as a fault in the shunt, increasing its resistance, was suspected; but there was nothing found wrong. When separately excited from accumulators, it, however, gave only 15 volts on open circuit. In vain the brushes were replaced and the brush holders cleaned. There was plenty of magnetism, for the armature got hot; yet no sparks, or next to none, at the brushes, even when short-circuited. Suspecting that some of the armature coils were short-circuited, an attempt was made to test the resistances between bar and bar of the collector, but without any very decisive results, owing probably to the roughness of the test. However, there were noticed some slight inequalities, which gave a clew to the cause of trouble. On examination it was found that nearly every one of the collector bars was more or less short-circuited to its neighbor by a charred mass of carbonized oil imbibed into the asbestos which formed the insulation. It was dug out with a penknife and replaced by another material, when the dynamo was restored to its proper activity. This vice has been of not unfrequent occurrence. Only a few weeks after the occurrence named, the writer received an urgent call to go to a town in a distant part of England, where a dynamo refused to work. Being unable to leave home that day, particular inquiries were addressed by telegraph, and yielded the information that it was a Siemens shunt machine, that all the circuits tested right, but still the machine would not excite itself. Instructions were dispatched to dig out the insulation between the collector bars, and the remedy proved effectual. Obviously, in such cases, oil ought not to be used on the collector, but only asbestos dust or French chalk. The writer has subsequently learned that a very similar trouble sometimes arises in certain machines that have collectors so constructed that there is a cylindrical cavity beneath the collector bars into which oil from the lubricators at the bearings may drain, and in which a charred mass ultimately forms, short-circuiting the entire collector. Another cause of trouble is the small metallic dust which flies from the collector when the brushes press so heavily as to produce ruts, entailing consequences, partly mechanical and partly electrical, that may end in a breakdown.

Among other faults of armatures that give trouble there is a purely mechanical one, arising from want of knowledge on the part of the electrical designer, namely, that of not being properly balanced. Every engineer worthy the name knows that a thing so balanced as to stand in any position is not necessarily balanced for running; that a four pound weight at three inches from the axis of rotation, though balanced statically by a one pound weight at twelve inches from the axis, is not balanced by it dynamically, for the moments of inertia about this axis are not equal. On the contrary, a four pound weight at five inches is balanced dynamically by a one pound weight at ten inches from the axis. A machine that violates dynamical principles can never be satisfactory. Short bearings where long ones would be appropriate; a high speed machine where a low speed machine is the only suitable sort (for example on ship-board); inside bearings where outside ones ought to be used, and *vice versa*—all these things have been and may still be answerable for breakdowns. So much the more reason is there for the electrical engineer to be engineer first and electrician afterward. Not that electrical knowledge is to be despised. The writer once heard an experienced engineer who had been put in charge of a dynamo which was lighting some arc lamps, and doing its work badly, declare that the trouble arose, not from an insufficient supply of current—he did not dispute the quantity of the current—but from the current being of a rather poor quality. There were, in point of fact, too many lamps in the circuit. Again, it is a fact furnishing food for reflection that in those electroplating shops in London where dynamos are used, the practical men in charge almost invariably hold the firm opinion that they are not getting the proper current unless they can see sparks at the commutator. They therefore so adjust the brushes that they get a good blaze. Sparking at the commutator or collector is a symptom of disease in a dynamo, just as truly as an outbreak of pustules is a symptom of disease in the human subject.

In the field magnets vices of construction are more frequent than acquired defects. Field magnet coils are sometimes wound on frames that are loose, or the coils are badly insulated. When the frames are loose, the resulting vibration not unfrequently causes the ends of the wires to snap off short. If there is a single short circuit between coils and iron work in the field magnet, then a single short circuit at any other point—armature coils, collector bars, brushes, brush-holders, or terminals—may work dire disaster. A little Brush machine lent to the Finsbury Technical College by the Anglo-American Brush Corporation had its commutator segments completely ruined in a few minutes by a curious double fault of this kind, which defied detection for several days. There were two short circuits, neither of which in itself would have done any harm whatever; but the iron support that held the rocker for one pair of brushes was so fixed by screws as to make a cross connection that short-circuited two pairs out of the four pairs of coils on the armature. A short circuit between coil and iron core of the field magnet is more likely to arise in shunt machines or compound machines than in series-wound ones, owing to the much higher electromotive force of the self-induced extra current if the shunt circuit is from any cause opened. Alternate current dynamos are liable to develop different kinds of faults from those to which direct current machines are liable.

They sometimes exhibit a curious pulsation of a determined slow period in their currents. The cause for this is probably purely mechanical. Again, machines for constant current are liable to disorders of a different nature from those of machines intended for constant potential work. The latter are more liable to overheat; the former are more troublesome in respect of sparking, because of the very great variations in the position of the neutral point.

Very little attention seems to have been paid to the question of the goodness or badness of insulating materials for resisting being broken down under working conditions entailed by damp, dust, and oil. Under such conditions it does not in the least follow that the material showing the highest insulation tests is the best. Very few dynamos will show, even when new, an insulation resistance between iron work and copper work amounting to anything like one megohm. Yet a dynamo that showed only ten thousand ohms of insulation resistance, and mechanically resisted being broken down, would be preferable to one the insulation resistance of which was a hundred megohms, if that high resistance were secured by employing brittle materials or materials that were destroyed by the presence of oil. Whether mica is in all cases preferable to asbestos, Willesden paper to vulcanized fiber, or shellac varnish to a solution of India rubber, or what other insulating materials should be prescribed in preference, can only be ascertained by a careful study of the failures that have from time to time arisen when one or other was employed.

Only by the study of the malady as it arises can the proper treatment be discovered to prevent its recurrence. In short, by the proper study of dynamo pathology, we may arrive at a fuller knowledge of dynamo therapeutics.

GRAPPLING AN OCEAN CABLE.

ONE of the marine novelties of the world that on rare occasions comes into this port is now lying at a dock in Erie basin, says the New York *Sun*. The novelty is the steamship Minia, Captain Samuel Trott, a vessel built and used for making repairs to the Atlantic telegraph cables belonging to the combination under the control of the leading men in the Western Union Telegraph Company. To a spectator on the dock the Minia would scarcely attract attention as a marine novelty. She is neither large nor small, her length being 328·5 feet, breadth 35·3, and depth 25·1. She is rigged as a topsail schooner, and she measures 1,986 tons gross. The one feature likely to attract the eye from the deck is the appearance of three big grooved iron wheels, side by side, just where the bowsprit projects from ordinary ships. A look about the deck and down some of the hatches, however, shows a number of peculiarities.

The Minia came here about four weeks ago, in order that she might repair certain injuries received about the rudder when engaged off the banks of Newfoundland in repairing a break in the Brest-St. Pierre line of the Anglo-American cable. The damage to the vessel was inconsiderable, for she was able to finish the repairs to the cable before coming here, but the details of the work of picking up the ends of a broken cable and splicing in a new piece, as related by one of the officers of the ship, are interesting. To one not familiar with the work, the sending of a ship to pick up the end of an inch wire rope 13,000 feet beneath the surface of the sea seems very much like a wild goose chase, but once the plans are understood it is simple enough, though somewhat tedious at times, not only to find the ends, but to pick them up and splice them to a new piece.

The break which the Minia was sent to repair occurred early last summer. The officers of the company first located the distance of the break from the stations on shore on each side of the ocean. The details of the instrument by which this is done are not easily described, though easily understood in principle. The machine consists of a series of coils of wire, which offer a known resistance to the electric current. Enough of the coils are connected to make a resistance equal to the resistance offered by the entire cable when it is in working order, and thus when the machine and the cable are connected a balance is effected. But if the cable should break, the balance is destroyed, because that portion of the cable between the shore station and the break, wherever it may be, will offer less resistance to the electric current than the entire cable would do.

Enough coils of wire are therefore disconnected from the machine to restore the balance. The resistance of the part of the cable that remains intact is thus accurately determined by the number of coils remaining connected with the machine. Having, when the cable was intact, learned the resistance which a mile of the cable offers, by dividing the entire resistance by the number of miles of cable, it is easy to find how many miles of cable are still in good order by dividing the entire resistance of the piece by the known resistance of one mile.

This explanation may be a little complicated to one not fond of mathematical demonstrations, but it is just as the Minia's officer made it, and it is remarkable for its lucidity when compared with explanations which electricians generally make. It is noticeable also from the fact that the word ohm, the name of a unit of electrical energy and the bugbear of every one who does not know anything about electricity, is wholly omitted.

Having determined how many miles from the shore station the break is, orders are sent to the Minia to go to the place, pick up the ends, and splice them to a new piece. Having received such an order and acted on it, Captain Trott found himself and his ship, on July 25 last, in latitude 42° 30′ north and longitude 46° 30′ west, or just to the eastward of the Grand Banks of Newfoundland, with one of the hardest jobs before him that he had had in some time, for sounding showed that the water was about 13,000 feet or a good deal more than two miles deep.

He knew he was somewhere near the break in the cable, but he did not know absolutely within about three or four miles, because while he had been able to determine his own position by repeated observations of the sun and stars, he could not tell how accurate the observations of the officers of the ship laying the cable had been.

The first work done was to get a series of soundings over a patch of the sea aggregating twenty-five or thirty square miles. The sounding apparatus consisted of an oblong shot of iron, weighing about thirty-two pounds, attached to a piano-forte wire in such a way that when lowered to the bottom the shot would jab a small steel tube into the mud down there and would then release itself from the wire and allow the sailors to draw up the tube with the mud in it. The moment the weight was released the men on deck stopped paying out the wire, and thus knowing how much wire had been run out, they were able to tell the depth. It is an interesting fact that it took twenty-four minutes and ten seconds for the weight of the sounding apparatus to reach bottom in 2,097 fathoms of water.

Having learned the depth of water and the character of the bottom, a big black pear-shaped buoy was put overboard and moored about where the end of the broken section ought to have been, according to the calculations. They buoy is made of boiler iron and is arranged to support two large white lanterns at night, for the work is carried on day and night, when the weather will permit. This buoy is kept from floating away with the tide by an anchor that looks like an open umbrella. Secured to the anchor which was put over was a 45 fathom section of chain, above that 510 fathoms of patent rope, invented by Captain Trott, and consisting of part steel wire and part hemp strands. It is designed for both strength and buoyancy. Then came 1,101 fathoms of pure manila rope, and above that enough of mixed wire and fiber rope of different kinds to reach the surface and secure the buoy.

The ship was now ready to begin the search proper for the cable. She was run off at right angles to the line of the cable for a distance of five miles and a buoy got down to mark the limits of the territory to be grappled over in that direction. Buoys were afterward set elsewhere to mark the other limits of the territory. The grappling iron was lowered over the bows, the rope attached to it passing over one of the three big grooved wheels that revolve where the bowsprit of an ordinary vessel stands.

The grappling iron used is the invention of Captain Trott. It looks something like a four-pronged anchor. It has a shaft four feet long, and four arms about a foot long that are set at right angles to each other at the bottom of the shaft. Right in each crotch formed by the arms is a little button that has a spring behind it that may be regulated in strength. The button projects a third of an inch into the crotch. The angle of the arms with the shaft is so small that a rock could not get down in so far as to reach the button, but when the cable is caught by the hooks it presses down against the button, and thus closes an electrical circuit through a copper wire running through the grapnel's rope and the grapnel itself, and a bell is set ringing upon deck. But the experienced men in charge of the grappling are generally able to tell what the hook has hold of without the bell's aid. They judge by the strain on the rope, which is indicated by a dynamometer on deck. The ordinary strain on the dynamometer is from three to three and a quarter tons when the grapnel is dragging freely over a smooth bottom as the vessel forges slowly ahead. Sometimes a rock catches on the hooks. This frequently breaks off an arm, but sometimes it fetches clear, the strain indicated by the dynamometer informing the old sailor man in charge whether an accident has happened or not.

It took two hours and twenty minutes to get the grappling iron from the bow of the ship down to the bottom of the sea, 13,000 feet below. The cable used to drag it with is the patent wire and hemp invention of the captain.

The dragging began on July 25, the day of arrival, but they swept backward and forward over the territory for ten days without finding the broken telegraph cable. A good part of the time they were steaming back and forth day and night, and the only time they were not doing so was when the weather was too bad. On such occasions they went to the buoy at the supposed end of the broken cable and hove to till the gale was ended.

Finally, on Aug. 5, the bell rang, indicating that the grapnel had caught the cable. The grapnel drag rope was thereupon fastened to a buoy and thrown overboard. Then the steamer went off two miles toward the end of the broken cable and got out a cutting grapnel. This is like the other one, except that there are knives in the crotches. When these crotches catch the cable and the strain comes on them, they cut the cable off clean.

"Why did you cut off the cable there?" was asked.

"Because if we had tried to get up the bight of the cable where we first found it, the cable might have broken under the strain. That cable was laid in 1869, and is getting pretty well along in years. It would have been as apt to break on the shore side as the other, but when we had only an end of two miles to deal with, we were sure of being able to get it up without damage. We grappled the European end first."

Having cut off the cable, the vessel returned to the buoy of the grappling rope, and getting the rope inboard again, led it to the drum six feet in diameter, located on the upper deck and operated by a steam engine. Then they began to wind in the grapnel rope and hoist the old cable to the bows. They started the drum at 1:20 in the afternoon of Aug. 5, and at 7:51 had the bight of it at the bow of the ship. Then the two miles and odd of end that was hanging down from the bow was fished up and stretched in length along the deck until the end was reached.

This was connected with a very complete cable telegraph office located amidships, and a second later the operators who had been on watch for days in the British station, awaiting this event, saw the flashes in a mirror in their office, that told them all about it.

Sometimes it happens that when an end of the cable is picked up in this way and an attempt is made to communicate with the shore, it is found that there is another break, and that they have only an end of an odd section lying loose. Then they have to drop that over, after testing it to see how long it is, and go on toward the shore and begin over again. In this case, however, they found that they had hold of a sound wire to Great Britain. Without any delay, the end of a new cable was spliced to the old end brought from the bottom. Two experts, one who is trained in splicing cores, and one who is trained in splicing the outside or sheathing, are employed in this work.

When the splice was completed and tested and found perfect, the cable was started running out around drums and grooved wheels controlled by brakes, and over the stern, the old end having been led fair through these sheaves before the splicing was done. Then the ship headed for shoal water and ran away at from three to four knots an hour, until over a part of the banks where work could be done more easily than where the water was more than two miles deep. Of course this involved the abandonment of a good many miles of old cable, but the old cable wasn't of very much importance anyhow.

Arriving in shoal water, the end of the new piece was attached to a buoy and put overboard. Then the old cable was grappled and cut as before and a new piece spliced to it. Then the ends of the two new pieces were spliced together and the job was complete. It had taken nearly two months to do it, although in the meantime two easier jobs were attended to and a trip to Halifax, for provisions, was made, not to mention the encountering of the storm that damaged the rudder.

The Minia has a crew of 90, all told, including the captain, three deck officers, a navigator, three expert electricians, four engineers, a purser, and a surgeon. A blacksmith and a boiler maker, with their tools, are carried. There are three big, round tanks to hold the 600 miles of cable carried, which includes sizes to fit all the old cables under the charge of this ship. There is a cell room, where the electricity for telegraphing is generated, and two dynamos with their engines, one to furnish electricity for a system of arc lights used when at work at night, and the other for the incandescent system that lights the ship below decks. The main saloon is large, and is comfortably and handsomely fitted. The captain has a cabin under the turtle back aft, as fine as any captain could wish for, and the other officers have rooms below that are as well fitted as those usually occupied by naval officers. The crew are all expert men, and get pay that averages a good deal better than the pay in the packet service between New York and Liverpool. The entire crew is kept under pay the year round, the ship making her headquarters at Halifax when not engaged in repairing cables. They are as comfortable a lot of sailor men as one could find anywhere.

A curious fact in connection with the immense amount of grappling done by this ship and the great number of samples of the bottom brought up by the sounding apparatus is that the only products of human ingenuity ever raised by either grappling iron or sounding apparatus were two anchors of modern construction and one sample of ashes, evidently from some steamship. It is said that enough sailors have been drowned between New York and Liverpool to pave the bottom of the sea from port to port, and that enough fishermen have gone down on the banks to cover them three feet deep: but no human remains have ever been brought up either by this ship or by any other dredger. Neither have any remains of the thousands of ships that have been wrecked in that region been encountered. What becomes of these wrecks and the bodies of the lost sailors is a mystery which the officers of the Minia have not been able to solve. Certainly, they say, if either remained intact on the surface of the sand at the bottom of the sea, either the grappling iron or the sounding apparatus in passing and repassing thousands of times over a part of the ocean where the wrecks are most numerous must bring up proof of their presence there.

PROF. RILEY ON THE IMPORTATION OF THE HESSIAN FLY INTO AMERICA AND INTO ENGLAND.*

PROF. RILEY, in answer to the question as to the probable date of the introduction of the species in this country, said there were probably as many conflicting views on the subject as had been expressed about its first appearance in America. Based on the facts that American grain growers had been practically unfamiliar with it prior to 1777; that its injuries on Long Island followed the landing of Hessian troops in the summer of that year; that its subsequent progress westward at the rate of fifteen or more miles a year was distinctly traced and recorded; and that Col. Geo. Morgan (who wrote most intelligently about it at the time) claimed, in his letter of August 26, 1788, to Sir John Temple, to have given it the name of "Hessian fly"—the consensus of opinion on the other side of the Atlantic had been with Fitch, who followed contemporary conviction at the time of the insect's first injury, and held that it had been imported into America by the Hessian troops. Balthazar Wagner, however, in an admirable paper (1861) argued it could not have been imported by the Hessians, his reasons being that, as had been long previously shown, it was not known to occur in Hesse, and that the historic evidence as to the times of departure and arrival of the troops taken together with the life history of the insect rendered such importation highly improbable, or, as he puts it, out of the question. Hagen (1880 and 1885), following Wagner, used the same facts and arguments, and added some further historic data; but, with more bibliographic zeal than biologic acumen, he went farther, and claimed that it was never imported, but was indigenous to America.

Prof. Riley said it would extend his observations beyond reasonable limits to enter into the details on which he based his own conviction, which had been substantially expressed in the full paper by Packard in the "Third Report of the United States Entomological Commission" (1883). His opinion was that while we might drop the Hessian theory, since Mr. Henry Phillips, Jr., as quoted by Hagen (1885), finds mention of the "Hessian fly" in the unpublished minutes of the American Philosophical Society for 1768 (a rather astonishing fact, as it antedates the landing of the Hessians!), and concede that the insect was introduced some time prior to the revolution, yet that its introduction *about* that time must be accepted, because Hagen's arguments to the contrary were not supported by evidence.

Prof. Riley further remarked that he had referred to these conflicting views of leading writers as to the original source and time of introduction of the insect into America, not so much to foreshadow the future conflict of opinion on similar points in England as to bring out this important fact as a warning to hasty generalizers, *viz.*, that the arguments of Wagner, Hagen, etc., against its introduction into America were inherently weak from the biologic side. They are based on the average or normal period of summer development of about seven weeks from egg to adult, *and ignore the important bearing of exceptional retardation in development whereby the puparia of one summer remain latent and only give forth the flies in the spring or early summer of the ensuing year.* This fact, recognized by Harris (1853), Prof. Riley said he had evidence of in America in garnered straw, and it was proved by Wagner himself to have occurred in Germany in field stubble. It was more apt to occur, however, in straw kept dry and packed than in stubble or exposed straw, and is in keeping with many other similar cases of retarded development in insects, some remarkable instances of which he called attention to before the American Association for the Advancement of Science in 1881. It destroyed Hagen's main argument, rendered the introduction of the species possible at almost any season, and made its introduction to America by the Hessians who left Portsmouth April 7 and landed June 3, 1777, on Staten Island, quite probable and plausible from biologic grounds. All the facts as to the history of the insect in Great Britain indicated its recent introduction. The lengthy inquiry carried on at the request of the Privy Council by Sir Joseph Banks a century ago, a full record of which will be found in Young's "Annals of Agriculture," etc. (vol. xi., 1789, pp. 406–613), proved quite conclusively that the insect was not here then, and there was no reason to suppose that since then it would long have eluded detection, whether by intelligent farmers or by entomologists like Kirby, Curtis, and Westwood. The first authentic record of its appearance in this country was that by Miss E. A. Ormerod last year (1886), and, as so often happens after the first announcement of a discovery, when public attention has been strongly called to a subject, hosts of observers have been on the *qui vive* for the insect who would otherwise never have looked for it. As a consequence, it had been detected during past summer along the eastern coast up into Northern Scotland; and this wide distribution would indicate that it had been at work unnoticed for some years previous to 1886, though it may also be accounted for by the simultaneous import of infested straw from some given locality into various ports along the coast. Prof. Riley said this last view was rather confirmed by the balance of the evidence and the statistics of straw importation, which, so far as he had been able to get at them, showed that straw is brought into Great Britain chiefly from France and Holland, and is carried almost entirely into eastern ports, the port of Glasgow (which reaches so near the eastern coast) being the only notable exception.

Much of the straw is also used for manure and distributed by rail. The fact that the insect is yet confined to the eastern counties is also confirmatory of its recent advent; for, had it been long in the country, we should expect it to be uniformly distributed over the grain-growing parts of the island. The testimony of farmers who think they saw the insect in years gone by (there have already been such, and there will be others!) is rarely, if ever, to be depended on; while entomologists who argue its indigenous character from the general ignorance of, or indifference to, the *Cecidomyidæ* on the part of British dipterists, or from the difficulty of separating the species of the genus *Cecidomyia* in the adult state, forget how unique in appearance and easily discerned the puparium is, and put mere opinion against established fact. In conclusion, Prof. Riley said he believed that the Hessian fly had, beyond question, been introduced into England since Curtis' time, and probably within the past three or four years.

* From the Proceedings of the Entomological Society, Oct. 5, 1887.

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